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NATIONAL GEOGRAPHIC

Vol. 196 1999 No. III-Dec

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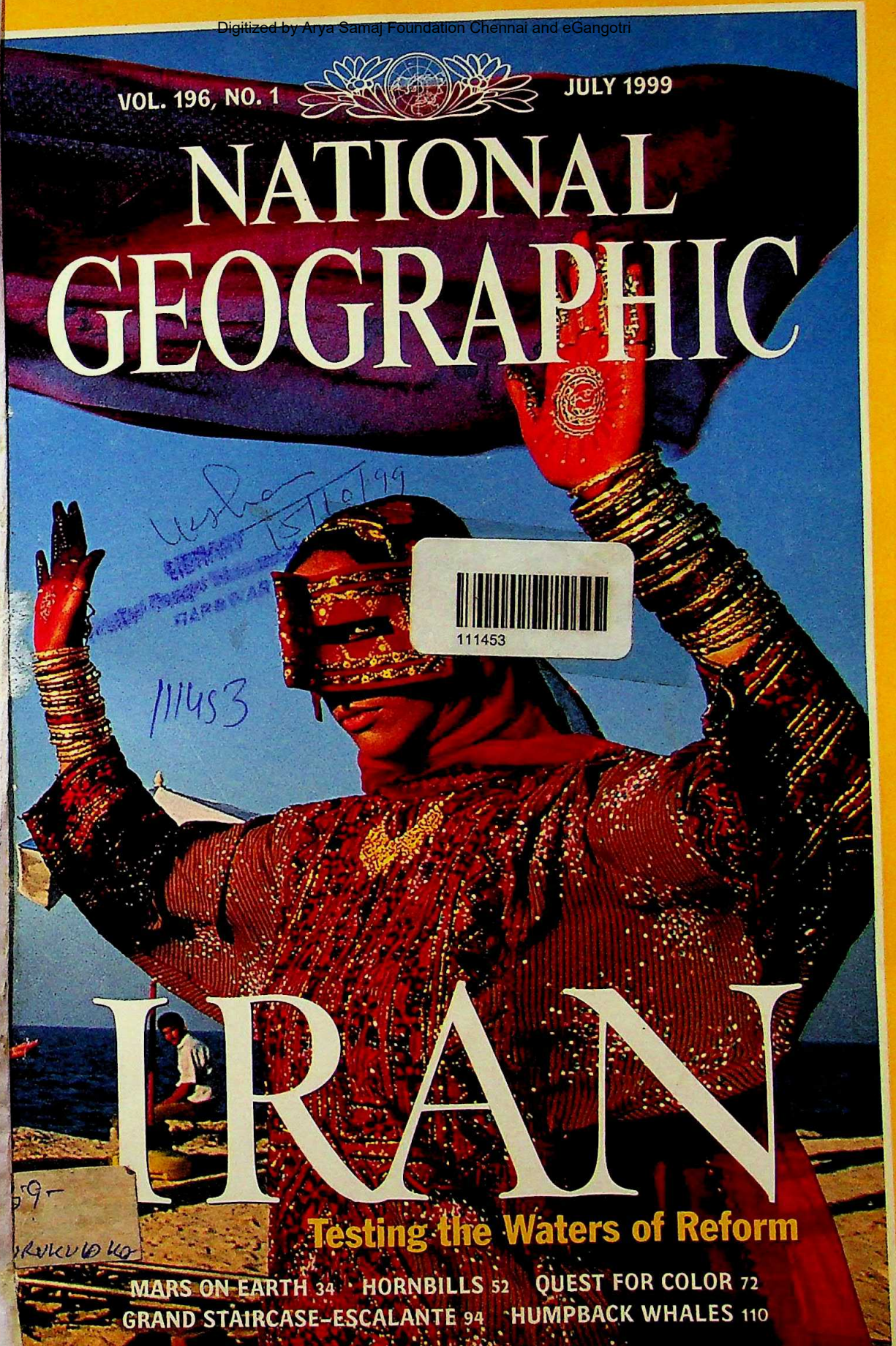
VOL. 196, NO. 1 JULY 1999

NATIONAL GEOGRAPHIC



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IRAN

Testing the Waters of Reform

MARS ON EARTH 34 · HORNBILLS 52 · QUEST FOR COLOR 72
GRAND STAIRCASE-ESCALANTE 94 · HUMPBACK WHALES 110

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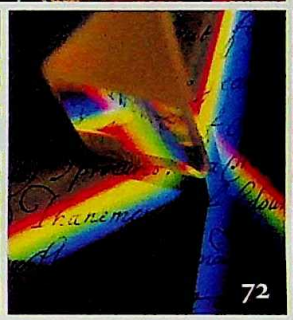

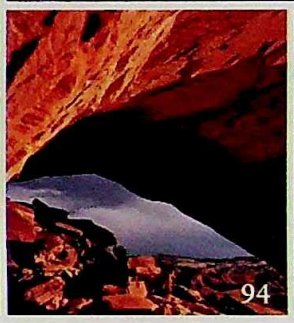

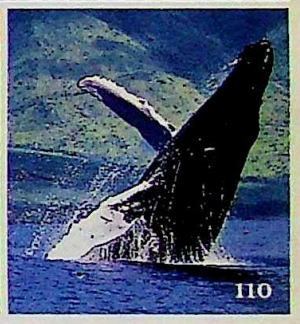

2 **Iran: Testing the Waters of Reform** *After two decades under the ayatollahs, many Iranians yearn for greater freedom and less state control. Their champion, President Mohammad Khatami, nudges the country toward more openness but faces a deepening power struggle.*
BY FEN MONTAIGNE PHOTOGRAPHS BY ALEXANDRA AVAKIAN

34 **Mars on Earth** *In the battered landscape of an impact crater, scientists in the Canadian Arctic find ideal ground for testing methods to explore the red planet.*
BY MICHAEL E. LONG PHOTOGRAPHS BY PETER ESSICK

52 **The Shrinking World of Hornbills** *From Africa to Melanesia, hunting and habitat loss threaten the survival of regal birds that nest in a way that is all their own.*
BY MICHAEL E. LONG PHOTOGRAPHS BY TIM LAMAN

72 **Quest for Color** *Battles raged over it, fortunes flowed from it, and songs and legends sprang from it. Today humans still scour the Earth—and the laboratory—for dyes and pigments to interpret and enhance their world.*
ARTICLE AND PHOTOGRAPHS BY CARY WOLINSKY

94 **Celebrating Canyon Country** *The creation of Grand Staircase–Escalante National Monument in southern Utah adds nearly two million acres of unsullied wilderness to the United States' cache of protected land.*
BY T. H. WATKINS PHOTOGRAPHS BY DIANE COOK AND LEN JENSHEL

110 **Humpback Whales** *In every ocean on Earth humpbacks sing, socialize, and make journeys as long as the sea is wide. Scientists record the songs, chart the travels, and observe the family life of these endangered giants, whose numbers now seem to be increasing.*
BY DOUGLAS H. CHADWICK PHOTOGRAPHS BY FLIP NICKLIN

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Costumed in traditional Baluchi garb, an Iranian actress tosses a cloth symbolizing the creative spirit of women in a film directed by her husband on Kish Island, Iran. Photograph by Alexandra Avakian

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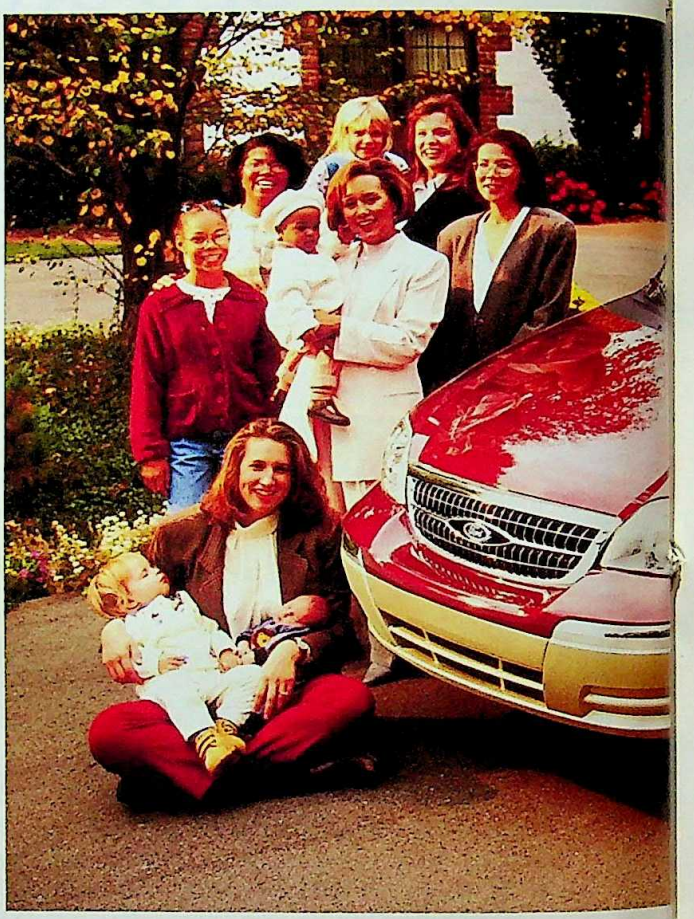
At Ford, we always listen to our mothers.



In fact, 30 of the 1999 Windstar Product Development Team members happen to be moms. Sure, they know torque converters. But they also know diapers, infant seats and juice boxes. And, because they know a thing or two about security blankets, you'll find that Windstar is the only vehicle to earn the government's highest rating – five stars – ★★★★★ in both front- and side-impact crash tests.* And their innovative thinking made Windstar just about as family-friendly as a minivan can be. After all, mother knows best.

*During side-impact crash test, Windstar was equipped with optional side airbags. Always wear your safety belt and secure children in the rear seat.

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NATIONAL GEOGRAPHIC

AUGUST 1999

2 **Global Culture** *As old patterns make way for new, our thinking and our ways of life become more urban, more cosmopolitan, less diverse. An introduction to this special issue.*
BY JOEL L. SWERDLOW

■ *Millennium Supplement: Culture*

6 **A World Together** *With Internet use soaring and airfares falling, global exchange of information, products, and ideas has exploded. Will our cultural differences survive?*
BY ERLA ZWINGLE PHOTOGRAPHS BY JOE McNALLY

34 **Tale of Three Cities** *Alexandria, Egypt, at the start of the first millennium; Córdoba, Spain, at the beginning of the second; and New York, New York, at the dawn of the third: What do they tell us about cities past, present, and future?*
BY JOEL L. SWERDLOW PHOTOGRAPHS BY STUART FRANKLIN

62 **Vanishing Cultures** *Indigenous peoples have become the human equivalent of endangered species. Now many battle to save the things that define them: their lifeway, their language, and their land.*
BY WADE DAVIS PHOTOGRAPHS BY MARIA STENZEL

90 **Italy's Endangered Art** *In a place where Roman coins lie underfoot and Renaissance frescoes adorn countless ceilings, preserving art treasures from natural disasters and the ravages of time requires the effort of an entire nation.*
BY ERLA ZWINGLE PHOTOGRAPHS BY O. LOUIS MAZZATENTA

110 **The Power of Writing** *An invention whose impact seems impossible to measure first appeared in Mesopotamia 5,000 years ago. Using systems of writing from Maya glyphs to Chinese calligraphy, humans have chronicled history, lobbied for freedom, and expressed the emotions of the ages.*
BY JOEL L. SWERDLOW PHOTOGRAPHS BY CARY WOLINSKY

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Seemingly a world apart, a fashion model poses with her more traditionally garbed mother in Mumbai (Bombay), India. Photograph by Joe McNally

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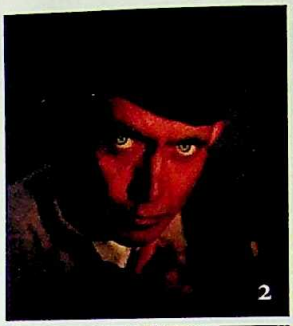

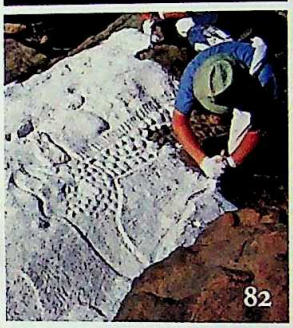

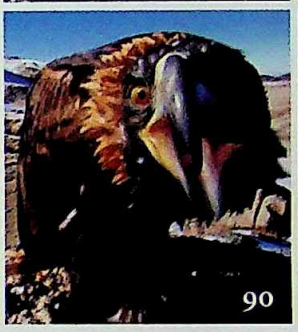

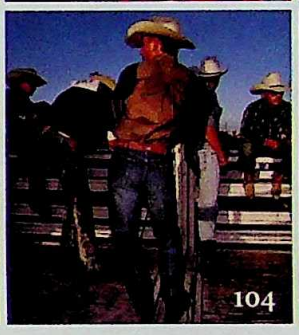

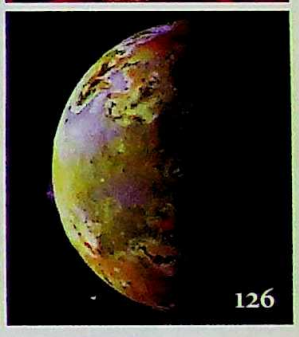

2 **Kashmir: Trapped in Conflict** *India, Pakistan, and Kashmiri separatists continue their increasingly dangerous struggle over Himalayan territory that once delighted residents and travelers alike.*
BY LEWIS M. SIMONS PHOTOGRAPHS BY STEVE McCURRY

30 **Around At Last!** *In March of this year, Swiss doctor Bertrand Piccard and British balloon instructor Brian Jones became the first balloonists to circle the globe nonstop. In an exclusive account, Piccard describes their journey.*
BY BERTRAND PICCARD

52 **Masai Passage to Manhood** *In an elaborate, emotional ceremony Africa's Masai elevate warriors to the status of elders.*
ARTICLE AND PHOTOGRAPHS BY CAROL BECKWITH AND ANGELA FISHER

66 **Olive Oil, Elixir of the Gods** *The world is discovering what Mediterranean peoples have known for millennia: The salubrious oil of the olive is an essential ingredient of the good life.*
BY ERLA ZWINGLE PHOTOGRAPHS BY IRA BLOCK

82 **Preserving the Sahara's Art** *Researchers make a cast of monumental giraffes carved into desert stone 7,000 years ago in Niger.*
ARTICLE AND PHOTOGRAPHS BY DAVID COULSON

90 **Hunting With Eagles** *On the high plateau of western Mongolia, ethnic Kazakhs practice a centuries-old tradition.*
BY CANDICE S. MILLARD PHOTOGRAPHS BY DAVID EDWARDS

104 **Rodeos—Behind the Chutes** *Getting bruised and broken more for love than money, cowboys ride broncs, wrestle steers, and otherwise get their kicks at dirt rings across the U.S. and Canada.*
BY MICHAEL PARFIT PHOTOGRAPHS BY WILLIAM ALBERT ALLARD

126 **Galileo Mission** *NASA's once troubled Jupiter spacecraft captures astounding images of the king of planets and its intriguing moons.*
BY WILLIAM R. NEWCOTT

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Breitling Orbiter 3 *soars above the Swiss Alps shortly after liftoff, as Bertrand Piccard and Brian Jones begin their historic three-week circumnavigation of the Earth. Photograph by Breitling SA*

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On Assignment

STEVE McCURRY

■ KASHMIR

In the Danger Zone

Though Pakistani artillery frequently traded fire with Indian troops across the Siachen Glacier, "I was really only worried about altitude sickness," says photographer Steve McCurry, at right, with a Pakistani soldier at a mountain army base. Their white parkas serve as camouflage in the snowy surroundings. "Since I wasn't acclimated to the 15,000-foot altitude, they were only going to leave me at this base for an hour. Then the weather got bad, and the helicopter came back two days later!" says Steve, who escaped with just a headache.

CANAT CHERYAZDAA

■ MONGOLIAN EAGLE HUNTERS

Feathers in His Cap

"Where I live in Arizona," says David Edwards, at left, "cowboys call an out-of-the-way spot 'behind God's back.'" Bayannuur, Mongolia, where he photographed eagle handler Suleyman, surely qualifies. David attended the London Film School after graduating from the University of North Carolina, then switched to still photography. When not shooting, he leads adventure tours—via horseback and river raft—to out-of-the-way places all over the world.

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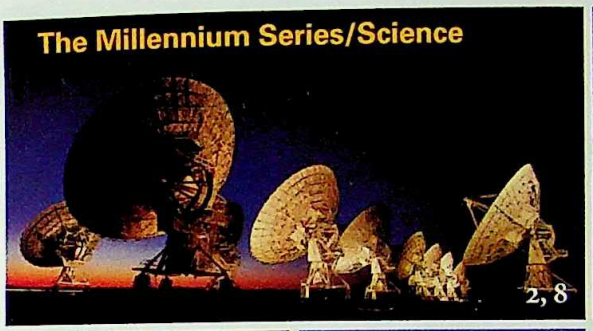

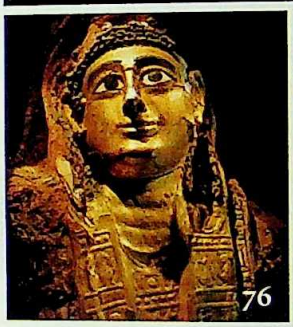

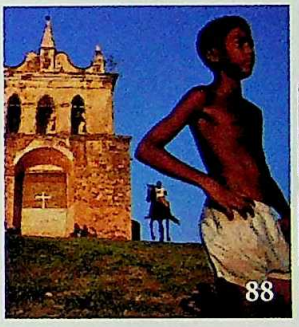

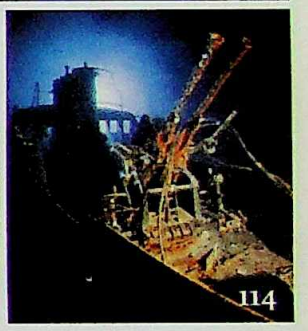

2 **Science—Asking Infinite Questions** *From the matter that makes up the universe to the strands of DNA that make us who we are, scientists are steadily unlocking the secrets of the ages.*
BY JOEL L. SWERDLOW

■ *Millennium Supplement: The Universe*

8 **Unveiling the Universe** *Astronomers claim the universe itself as their laboratory. Their subjects: black holes, exploding stars, and alien worlds that could harbor intelligent life.*
BY KATHY SAWYER PHOTOGRAPHS BY JOE McNALLY

42 **Secrets of the Gene** *As scientists race to crack the code of human life, breakthroughs in genetic research are yielding powerful new tools that hold shining promise and raise unsettling questions.*
BY JAMES SHREEVE PHOTOGRAPHS BY KAREN KASMAUSKI

76 **Valley of the Mummies** *Archaeologists at an Egyptian oasis have uncovered a vast burial site containing gilded mummies and stunning artifacts from a world that vanished nearly 1,700 years ago.*
BY DONOVAN WEBSTER PHOTOGRAPHS BY KENNETH GARRETT

88 **Cuba's Colonial Treasure** *Rich in 18th-century architecture, the small town of Trinidad has been acclaimed a World Heritage site.*
BY A. R. WILLIAMS PHOTOGRAPHS BY DAVID ALAN HARVEY

108 **George Mallory** *This spring the author found the body of the British mountaineer who disappeared 75 years ago while climbing Mount Everest. Was Mallory the first man to reach the summit?*
BY CONRAD ANKER

114 **The Last Dive** *In 1944 the Japanese submarine* I-52 *made a fatal attempt to deliver precious cargo—including two tons of gold bound for the Japanese Embassy in Berlin. Three miles deep in the Atlantic, the wreck of the submarine yields a wealth of memories but no gold.*
BY PRIIT J. VESILIND PHOTOGRAPHS BY JONATHAN BLAIR

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A creation of genetic engineering, this piglet has been bred to carry the human DNA needed to produce factor VIII, a blood-clotting protein. Photograph by Karen Kasmauski

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Breaking News

Dinosaurs for the New Millennium

Dramatic finds from fossil beds in Liaoning Province, China, reveal that many theropods, or meat-eating dinosaurs—a group that includes *Tyrannosaurus rex*—bore feathers at some stage in life. Among the newly discovered creatures is *Sinornithosaurus millenii*, or "Chinese bird-reptile of the millennium" (above). With long flapping arms and a coat of feathers *Sinornithosaurus* is the closest yet that a dinosaur has come to being a bird. But it is not a bird; it belongs to the family of theropods known as dromaeosaurs—sharp-clawed predators that include the "raptors" of *Jurassic Park* fame. Adding dromaeosaurs to the list of feathered theropods puts another link in the evolutionary chain from dinosaurs to birds.

NATIONAL GEOGRAPHIC has worked closely with the paleontologists in preparation for the announcement of these discoveries. In a forthcoming issue we will present a comprehensive coverage of *Sinornithosaurus* and the other new finds that will forever change the way you view dinosaurs.

For more details, visit our website: *www.nationalgeographic.com/news*

MODEL BY BRIAN COOLEY; PHOTOGRAPH BY O. LOUIS MAZZATENTA

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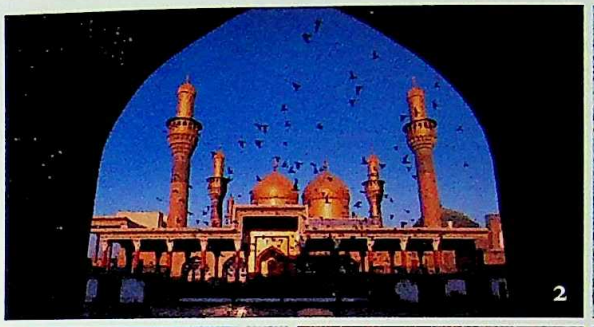
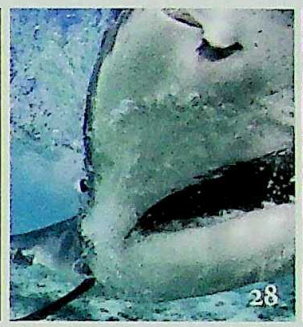
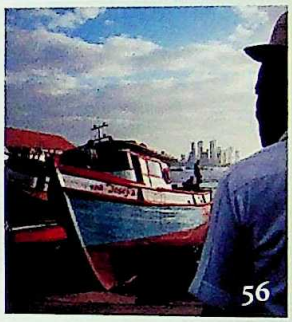
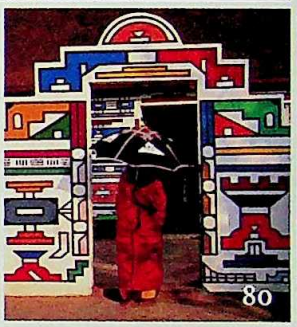
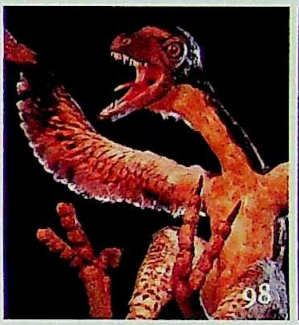
NOVEMBER 1999

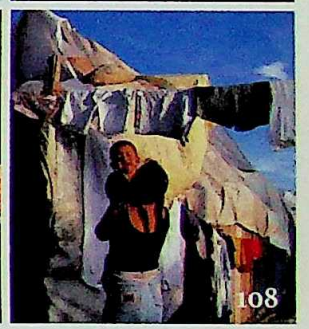












2 **Eyewitness Iraq** *Oil-rich Iraq has spent a fortune on war, but the country's treasure—among the largest petroleum reserves in the world—has bought neither peace nor prosperity for the Iraqi people.*
BY MIKE EDWARDS PHOTOGRAPHS BY MICHAEL YAMASHITA

28 **Tiger Sharks** *A feathered feast awaits the big predators in Hawaii when fledgling albatrosses take to sea.*
ARTICLE AND PHOTOGRAPHS BY BILL CURTSINGER

36 **Frozen in Time** *Three 500-year-old mummies unearthed on a 22,000-foot peak in the Andes tell an extraordinary story of Inca worship and child sacrifice.*
BY JOHAN REINHARD PHOTOGRAPHS BY MARIA STENZEL

56 **Panama's Rite of Passage** *When the United States hands over the Panama Canal in December, Panama will be without its biggest benefactor and on its own for the first time.*
BY LEWIS M. SIMONS PHOTOGRAPHS BY ALEX WEBB

80 **African Marriage Rituals** *Draped in silver or intricate bead jewelry, brides follow age-old traditions in elaborate wedding ceremonies from Morocco to South Africa.*
ARTICLE AND PHOTOGRAPHS BY CAROL BECKWITH AND ANGELA FISHER

98 **Feathers for *T. rex?*** *Spectacular fossil finds from China and Mongolia provide important new links between birds and their dinosaur predecessors.*
BY CHRISTOPHER P. SLOAN PHOTOGRAPHS BY O. LOUIS MAZZATENTA

108 **After the Deluge** *Already sodden at the end of the rainy season, Central America was ripe for disaster when Hurricane Mitch struck last fall. Survivors recall the Atlantic's deadliest tempest in two centuries.*
BY A. R. WILLIAMS PHOTOGRAPHS BY VINCENT J. MUSI

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Clothing intact, this gold figurine was found with the exquisitely preserved mummy of an Inca boy sacrificed 500 years ago on an Andean peak in present-day Argentina. Photograph by Maria Stenzel

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NATIONAL GEOGRAPHIC

DECEMBER 1999

The Millennium Series/Geographic Century

2 **Cheetahs—Ghosts of the Grasslands** *Hunted by ranchers, attacked by lions, and deprived of much of their African and Asian habitat, cheetahs in the wild number perhaps 12,000. Can conservationists move quickly enough to protect the world's fastest land animal?*
BY RICHARD CONNIFF PHOTOGRAPHS BY CHRIS JOHNS

32 **Florida Keys: Paradise With Attitude** *Paying the price of popularity, this South Florida island chain faces escalating real estate costs and degradation of the only living barrier reef in the continental U.S. But that hasn't stopped the party.*
BY FRANK DEFORD PHOTOGRAPHS BY BOB SACHA

54 **Ancient Greece** *Echoes of Homer's epic poem the* Iliad *emerge from Bronze Age sites around the Aegean Sea in the first of three articles about this legendary civilization.*
BY CAROLINE ALEXANDER PHOTOGRAPHS BY JAMES L. STANFIELD

■ *Double Map Supplement: Ancient Greece*

80 **Geographic Century** *As the Society pushed the technological boundaries of photography, its staid research journal was transformed by arresting images of our world.*
BY WILLIAM L. ALLEN

102 **The Brothers Grimm** *Snow White, Rumpelstiltskin, Little Red Riding Hood: The fairy-tale characters that have entered world culture came alive on paper in the early 1800s when Jacob and Wilhelm Grimm collected oral tales in their German homeland.*
BY THOMAS O'NEILL PHOTOGRAPHS BY GERD LUDWIG

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BY VALERIE A. MAY

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Cheetah cubs in northern Botswana's Okavango Delta face threats from both man and nature in their struggle to reach adulthood. Photograph by Chris Johns

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On Assignment

W. ALLAN ROYCE, NGS (BELOW); O. LOUIS MAZZATENTA

■ GEOGRAPHIC CENTURY

Shooting Stars

The people behind the people behind the cameras make some of the GEOGRAPHIC's most spectacular pictures possible, helping photography go places no one thought it could. Braving problems from high humidity to low altitude, they're usually successful: Waterproof lights and camera housings the photoengineering team designed helped get dramatic shots of the sunken *Titanic*. But the plane-cam "Albatross" (above) was a bust. It flew well, and the nose-cone camera worked fine, but the buzz of its engine frightened away the migrating geese it was supposed to photograph. The team includes, left to right, Joe Stancampiano, Kenji Yamaguchi, Roger Helmandollar, Phil Leonhardi, David Mathews, Walter Boggs, and Larry Maurer; not shown are Keith Moorehead and Edward Samuel. We also depend on our electronics shop to lend assignments some spark. Electronics technicians Ted Johnson (left, adjusting camera from below) and Anthony Peritore made regular trips to the Kennedy Space Center for the space shuttle launches with Illustrations Editor Jon Schneeberger, far left, and NASA's Richard Miller. "Early on we designed a sound trigger to start the camera's motor drive at a certain decibel level," says Ted. "The roaring rocket engines were supposed to set it off, but at first we got great pictures of a turkey vulture with a really loud squawk."

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NATIONAL GEOGRAPHIC MAGAZINE

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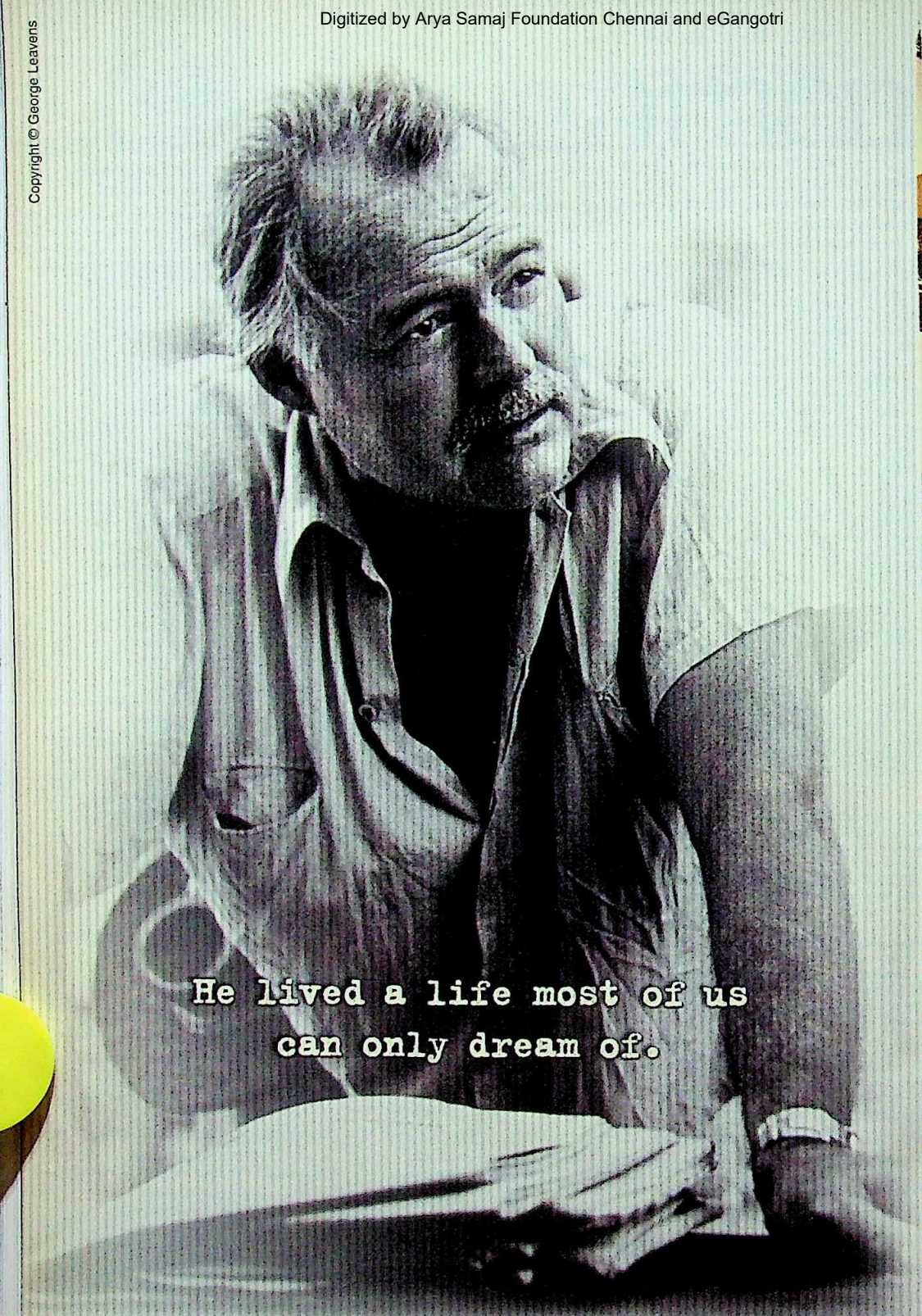

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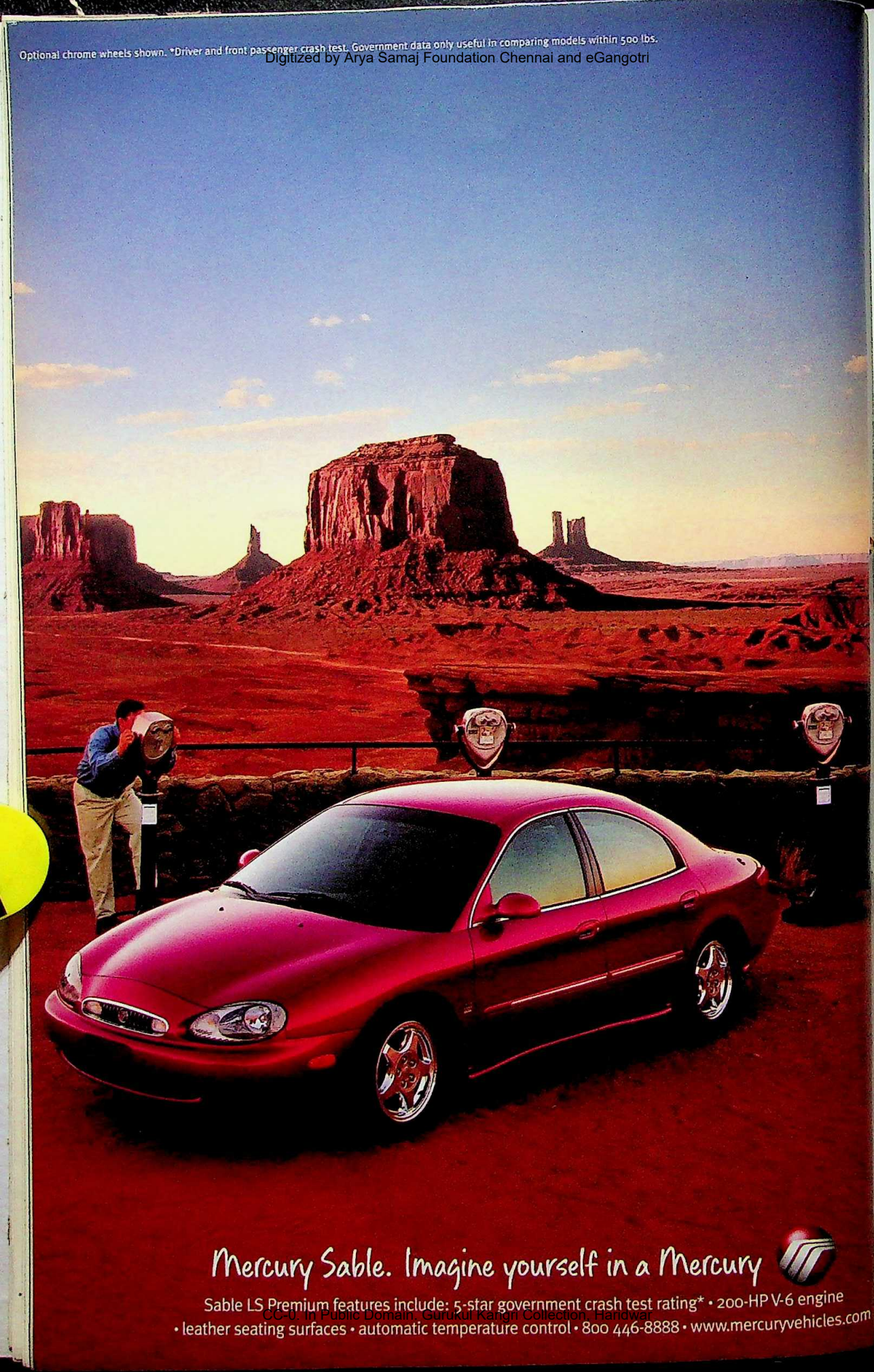

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NATIONAL GEOGRAPHIC

ALEXANDRA AVAKIAN

From the Editor

ON A HILLTOP OVERLOOKING TEHRAN the women gathered in their traditional dark shrouds. It is customary to stay out of the house on this, the 13th day of the Persian New Year, in order to prevent bad luck.

That was good luck for photographer Alexandra Avakian, who accompanied the women to their aerie for a rare glimpse of everyday life in Iran. She and author Fen Montaigne traveled the length and breadth of the country, which has been virtually closed to free movement by Americans since the revolution in 1979.

Two decades ago this fall Americans were taken hostage at the U.S. Embassy in Tehran. This month's article marks the most extensive look at Iran by any U.S. publication since then. It is a testimony to the NATIONAL GEOGRAPHIC's long-standing good reputation in Iran—where even in the darkest diplomatic days we had members—and to the changing political climate as voices of moderation urge a tentative rapprochement with the West.

In the interest of continued exploration of Iran, it is my hope that those voices will persist. But whatever the future brings, we can be thankful that an opportunity presented itself for the GEOGRAPHIC to take another long look at this ancient land.

Bill Allen

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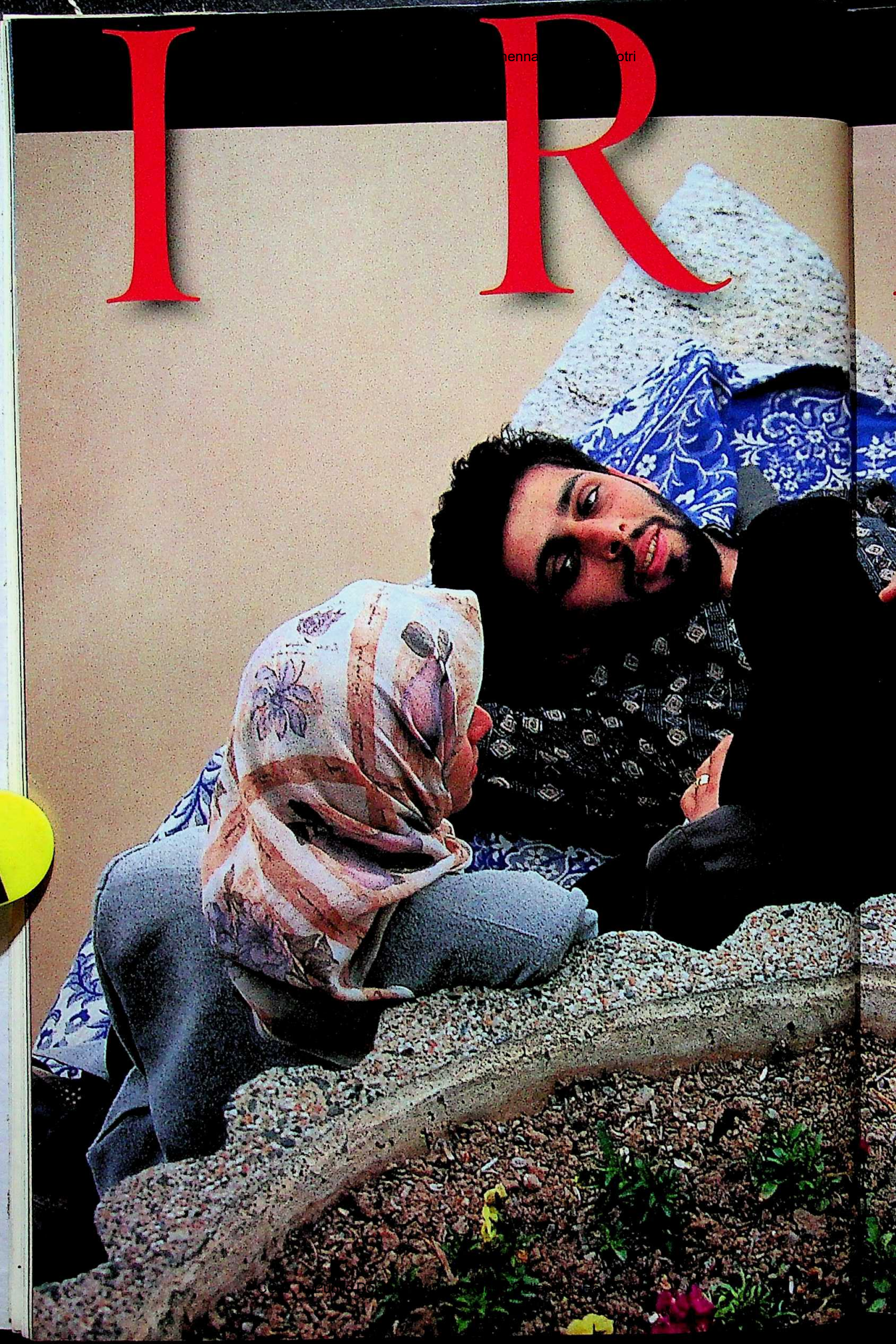
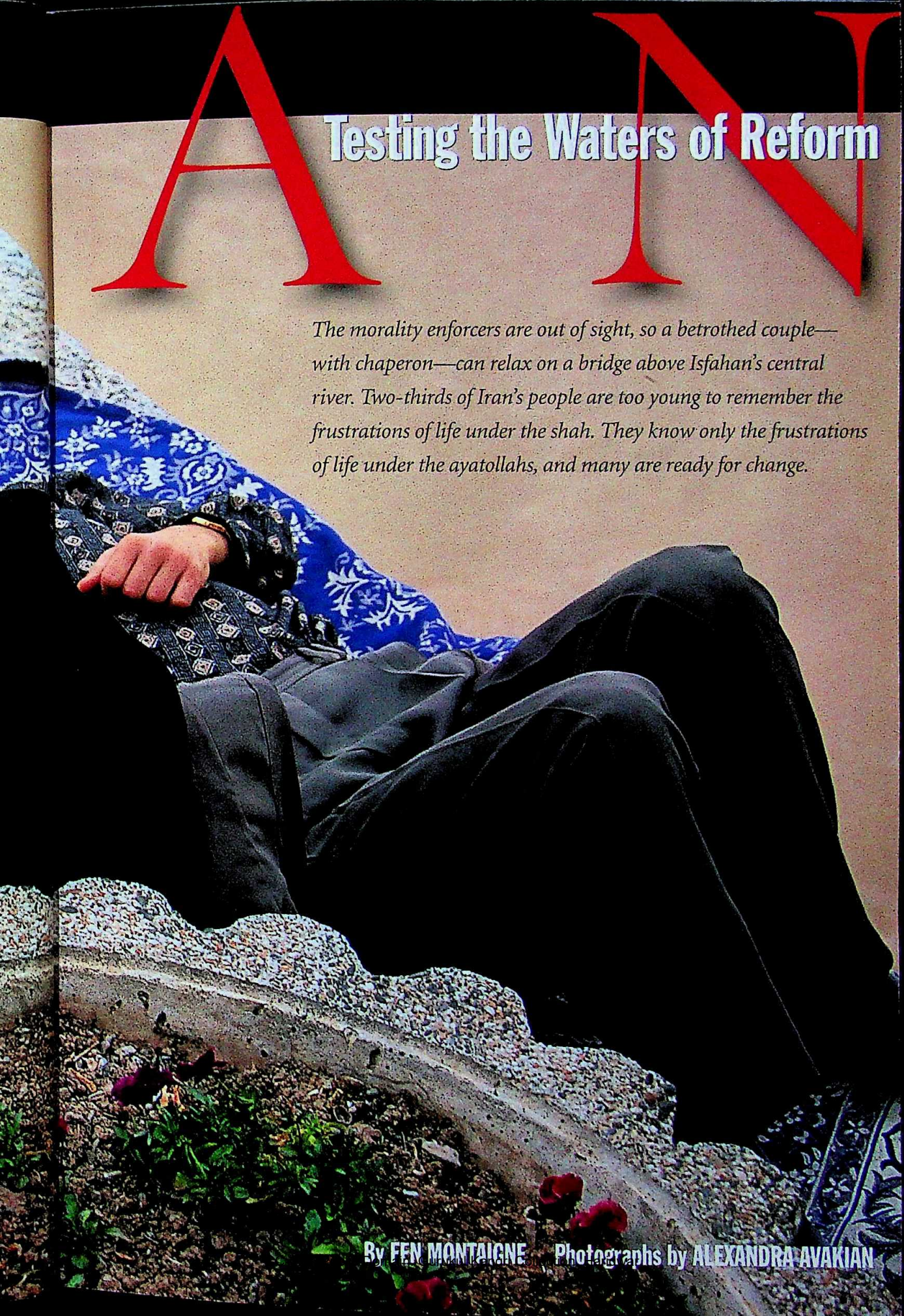


A N

Testing the Waters of Reform

The morality enforcers are out of sight, so a betrothed couple—with chaperon—can relax on a bridge above Isfahan's central river. Two-thirds of Iran's people are too young to remember the frustrations of life under the shah. They know only the frustrations of life under the ayatollahs, and many are ready for change.



By FEN MONTAIGNE Photographs by ALEXANDRA AVAKIAN

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Father of Iran's 1979 revolution, *Ayatollah Khomeini is always near, but now all eyes are on*

reformist president Mohammad Khatami. He won 70 percent of the vote but has limited power.

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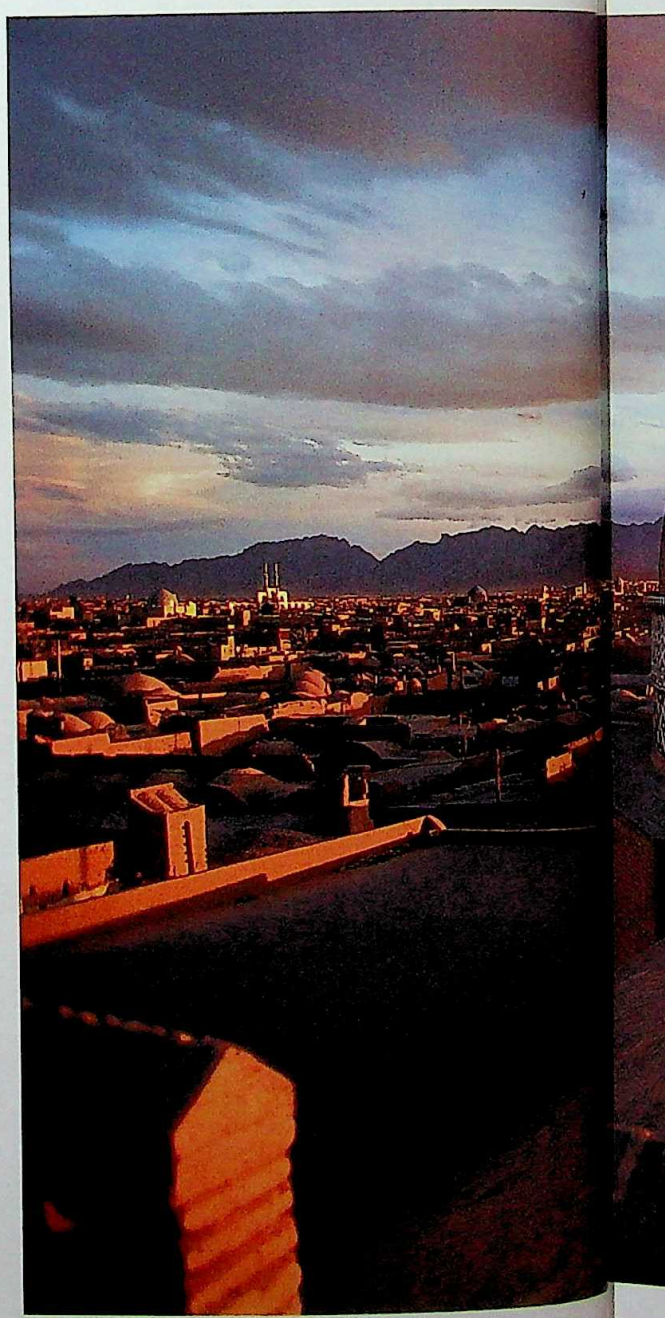
ON A SPARKLING AFTERNOON IN APRIL, 30 young couples climbed the steep hiking trail that follows the Darakeh River in northern Tehran. The river rushes out of the Elburz Mountains, whose snow-covered peaks form a majestic backdrop to the nondescript sprawl of the capital. At nearly 5,000 feet the area along the Darakeh is one of the few refuges from the dirty air and clamor of Tehran, and on this Friday, an Islamic day of rest, the couples were chatting easily as they strolled under willows and plane trees loaded with brilliant green buds. They passed vending stalls where merchants offered dozens of varieties of nuts and dried fruits or sodas cooled in old bathtubs filled with frigid river water. Men popped corn on propane stoves. Nearby, people paid a few hundred rials (about a dime) to a man whose parakeets told fortunes by strutting along a line of folded papers and pecking out missives that predicted wealth, long lives, and marriage.

Suddenly a stranger in civilian clothes approached one of the young men, Majid Rafiai, barking, "What are you doing? Why are you holding that woman's hand? Are you afraid someone will steal her?" In Iran, displays of affection between the sexes, however innocuous, are frowned on.

The inquisitor was a *basij*, a term often used disparagingly to describe people who, with the blessing of the authorities, act as guardians of public morals. The word originally applied to the members of a loose-knit Islamic militia, many of whom served as suicide fighters in the war with Iraq from 1980 to 1988.

The young people were indignant at the intrusion but held their tongues. Later I sat with them on a carpeted platform above the river, drinking tea and listening as they vented their anger. They said they had voted for the popular new president, Mohammad Khatami —a moderate clergyman, intellectual, and former minister of culture who ran on a platform of greater openness—precisely because they were tired of this kind of meddling from



Marco Polo *called it the "good and noble" city of Yazd, an ancient town where desert architects learned to cool buildings and even make ice by harnessing the wind. A 14th-century mosque still dominates Yazd's oldest quarter.*

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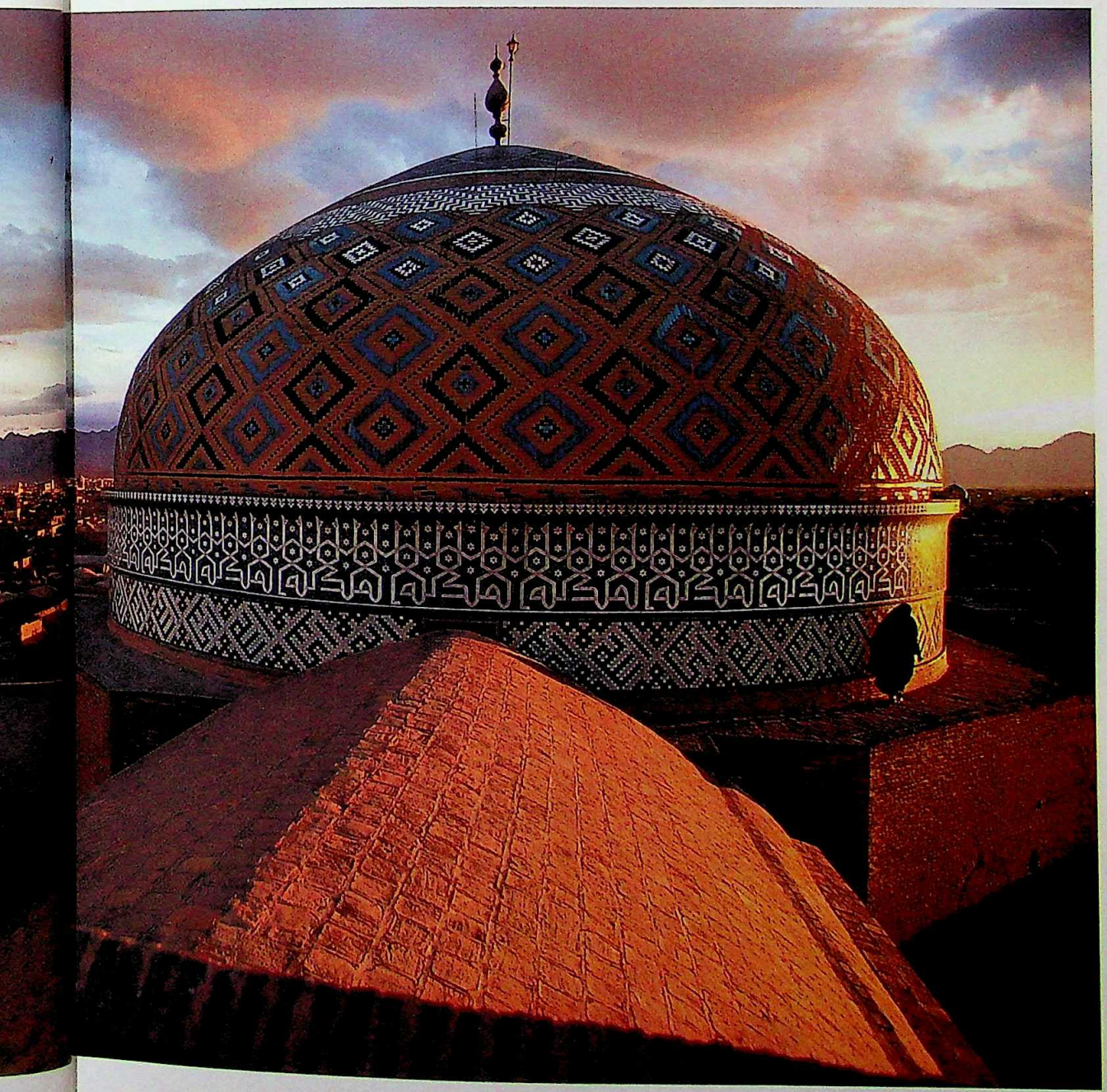
the die-hard defenders of the Islamic regime.

"The period of Khatami has come, and the period of those people is finished," said Hossein Youssefian, a 24-year-old university student, as the others nodded in agreement.

Twenty years after Ayatollah Ruhollah Khomeini and his devoted followers overthrew Shah Mohammad Reza Pahlavi—the last in a line of Persian monarchs dating back to Cyrus in 559 B.C.—and installed a religious government, many of Iran's 64 million people are fed up with the scowling clerics who have run their country and their lives. The dissatisfaction boiled to the surface in May 1997, when 70 percent of the electorate chose Khatami as president. Since his election Iran has been undergoing an uneasy transformation, a second revolution in as many decades and one that seeks to soften the overbearing rule of the theocracy.

"When I look at Iranian society, I see a society that has graduated from the school of fundamentalism," says Mohammad Jafar Mahallati, who served as Iranian ambassador to the United Nations under Khomeini and is now a professor in the United States.

As Iran struggles to liberalize its Islamic republic (no one would suggest publicly



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Seven years after *censors found fault with his last film, Bahram Beyzaie, in green, is shooting*

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ooting again; he credits Khatami. Even with restricted content, Iranian films have drawn critical acclaim.

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that the theocracy be scrapped), the big question is how far Khatami's geniality and popular support will carry him in his contest with the hard-liners, headed by Ayatollah Ali Khamenei, the "supreme leader" of the republic. What is certain, however, is that Iranians, after two decades of war and revolution, want some freedom and levity back in their lives.

"People are very tired," said Farideh Farhi, a political scientist. "We didn't expect so much austerity. Severity is against our nature. We like fun. We like color."

Certainly that was the country I found during a seven-week visit to Iran, a stunning land of desert plateaus, verdant Caspian shoreline, and two great mountain ranges, the Elburz and the Zagros. I had traveled in Iran in 1974, several years before anger over government corruption and the shah's pro-Western, anticlerical policies would ignite the revolution. I arrived this time with stereotypical images of the Islamic republic in my mind: the menacing, bearded face of Ayatollah Khomeini, the 52 blindfolded American hostages, the black-robed women burning the United States flag. But these images faded as I met with warmth and hospitality, surprisingly little anti-American sentiment, and a people longing for improved relations with the West and a more prominent place on the world stage.

I also discovered that under the Islamic revolution many Iranians had seen basic improvements in their lives: Paved roads, water, and electricity in most rural areas; access to higher education for the masses, especially women; and a greater sense of unity in this richly multiethnic nation, whose population includes 51 percent Persians, 24 percent Azerbaijanis, 7 percent Kurds, 3 percent Arabs, and numerous tribal groups.

Although the mood of Iranians has shifted under Khatami, the fundamentalist laws and customs of the Islamic republic remain in place. Under Iran's constitution the real power rests with Khamenei, the orthodox heir to Ayatollah Khomeini, chosen by a council of religious leaders. Khamenei is not nearly as popular as Khatami, nor does he have the charismatic Khomeini, who died in 1989 and is still revered by devout Iranians. Yet Khamenei and his allies control the army, the police, the judiciary, and the Revolutionary Guard, a volunteer unit originally created as a parallel force to the army. They also have a core of powerful supporters, including businessmen and bureaucrats tied to the regime, as well as veterans and war widows who receive government stipends.

Today the struggle between the two sides overshadows everything else, and change comes in fits and starts. Newspapers proliferate, exploring the limits of the allowable, and then are shut down; reform politicians, such as Gholamhossein Karbaschi, Tehran's mayor, are convicted on dubious corruption charges; five critics of the regime are mysteriously killed, and the government announces that rogue agents of the Intelligence Ministry have been arrested for the slayings.

I SAW FIRSTHAND how fluid the situation is when I interviewed Mashallah Shamsolvaezin, the editor of *Society,* one of the country's new, rambunctious newspapers. Shortly after the revolution Shamsolvaezin was the first editor of a militantly Islamic newspaper. But he had mellowed, and in early 1998, encouraged by Khatami's brand of *glasnost,* he founded *Society,* located in a house in central Tehran. Shamsolvaezin, a chain-smoking intellectual, smiled as he recounted how his newspaper had broken new ground by printing mildly critical stories about the government and by publishing two front-page color pictures of women—one in tribal dress, the other in a Western-style wedding gown.

"We have freedom of speech in Iran," he joked. "But it's what happens after we speak that becomes a question."

He would soon find out. The increasingly bold editor published several tough stories, including an interview with an opponent of the regime who had been jailed for 15 years and tortured. In June 1998 a court that oversees the press ordered the paper closed. Shamsolvaezin opened another paper, *Tous,* which published a number of controversial articles and was shut down on vague charges of undermining national security. Authorities then tossed Shamsolvaezin in jail for several weeks. Undeterred, he started a third newspaper.

Atlanta-based writer FEN MONTAIGNE wrote about the Trans-Siberian Railroad for the June 1998 magazine. ALEXANDRA AVAKIAN gained unprecedented access to Iran for this coverage. Her photographs last appeared in the September 1998 article about Romania.

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Millennia of political *and religious change haven't stamped out No Ruz, the Persian New Year that celebrates spring's new life, symbolized in Iranian homes by goldfish. Hearts turn to mourning in the Islamic month of Muharram. On the tenth day, when performers reenact the martyrdom of the Prophet Muhammad's grandson Husayn, people weep for the dead, including martyrs from the 1980s war with Iraq.*

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As the larger struggle has unfolded in Iran, many citizens have watched quietly, hoping Khatami and the reformers will prevail.

"We are a very complicated people," said Shahla Lahiji, a publisher and advocate of women's rights who lives in Tehran. Lahiji is a handsome woman with pale skin, prominent cheekbones, and a deep, infectious laugh. "We always live two lives—one outside the home and one inside. Obedience was always for the outside. Disobedience was for the inside. Outside we don't trust anyone. It is the reason for our survival. We had all these invasions, but we still have our language, and we still have our land. We obey the invaders, then change them."

Iran's 2,500-year-old civilization has survived invasion by Mongols, Turks, Afghans, and many others. Lahiji's unspoken message,

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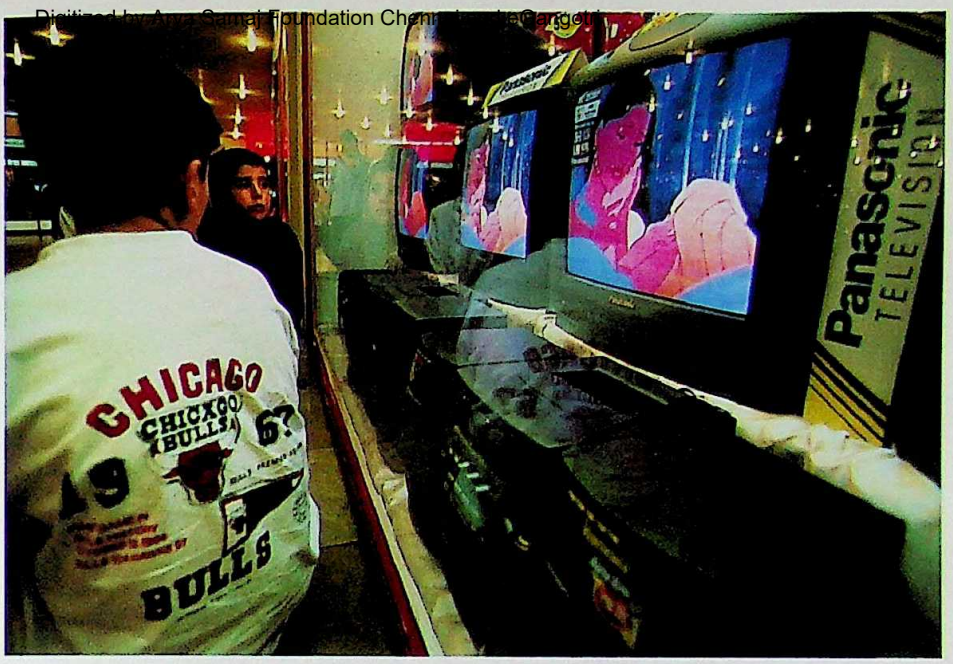

U.S. pop culture *and Japanese electronics fill stores in Kish, one of Iran's free-trade islands in the Persian Gulf. People come to buy, to relax, and to enjoy things forbidden elsewhere—men in shorts, women on bikes, love songs in cafés.*

Roughly half the size of India, Iran has 64 million people—twice as many as 20 years ago. Half are of Persian descent, and one-fourth are ethnic Azerbaijanis. Iran hosts almost two million refugees—more than any other country in the world—mostly Afghans and Iraqi Kurds.

I surmised, was that the harsh regime of the ayatollahs has become alien in its own land, forcing millions of Iranians to express their true feelings only behind closed doors. So I was surprised, on my travels, at how willing people were to criticize the government.

I had one such encounter on the edge of the Dasht-e Kavir, an austerely beautiful scrub desert broken by occasional high sand dunes. My traveling companion, Farokh Mostofi, editor of *Shekar-o-Tabiat*, a nature magazine based in Tehran, and I were exploring outposts along an old camel caravan route from Yazd to Tehran. We drove along the edge of the desert on a dirt track in Mostofi's four-wheel-drive. To the north, for several hundred miles, lay the empty Kavir, a brown waste dotted with rocks and shin-high, sagelike shrubs. Dust cyclones skittered across the landscape. A half mile away, a shepherd led his sheep and goats home under an enormous blue sky across which sailed gray-bottomed clouds.

We decided to spend the night in Ashin, a hamlet consisting of a dozen or so domed mud houses perched on a hill at the southwestern edge of the Kavir. Only two families were in residence, the others having abandoned the hard life of shepherding and farming for jobs in larger villages and cities. The holdout families tended a green-and-khaki-colored patch of wheat, cumin, and fruit trees at the base of the mountains, a lush oasis fed by a stream.

As the sun set behind clouds and a full moon rose in the eastern sky, Mostofi and I sat on a rough carpet outside one of the houses, eating and talking with the two families. By the light

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of a hissing kerosene lamp, a gaunt man with sunken cheeks covered in white stubble relaxed with the gregarious Mostofi and spoke freely.

"Islamic government is a myth; it's propaganda," said the man (whom I'll leave nameless), echoing a widely held sentiment that the ruling clerics and their families have become nearly as corrupt as many of the shah's top officials were known to be. "I doubt these people are working for Islam. They're just collecting money for themselves."

He also doubted whether the president could get much done in the face of intransigent hard-liners. "Khatami has good policies, but he can't challenge the powers against him," he said. "He can't even move a glass of water from here to there." Indeed, understanding the intensity of his opposition, Khatami has moved very slowly on reforms.

That night I unrolled a thin sleeping bag on the flat mud-and-straw roof of one of the abandoned houses. The hard bed made for a fitful night, but the discomfort was offset by the sight of the moon creeping across the sky, suffusing the rugged desert landscape with an ethereal light.

THE HIGH HOPES Iranians had for Khatami have been tempered by time and the slow pace of change. But two years ago his candidacy stirred passions that caught the fundamentalist regime utterly by surprise. One of four presidential candidates approved by a religious council, Khatami delivered a restrained, often populist message that caught on like a prairie fire. He emphasized respecting people's privacy and guaranteeing their "civil rights and freedoms." His gentle demeanor, as much as his words, won over the Iranian people.

"Everybody was depressed," said Shahla Lahiji, the Tehran publisher. "It seemed that laughing was forbidden. Khatami had a huge open smile. He showed he cared about people."

His election also showed that the yearning for change cuts across Iranian society: women, resentful of inequities and restrictions; journalists, intellectuals, and artists, chafing under government censorship; workers and businessmen, weary of the economic stagnation brought on by the government's mishandling of the economy; and, most of all, the young. In Iran 40 million people are younger than 25 years old. Comprising two-thirds of the population, they are the baby boom that followed the 1979 Islamic revolution. Many of them have no memory of either Ayatollah Khomeini or the birth of the Islamic republic.

In the small town of Zagh Marz on the Caspian Sea a fisherman in his early 30s, Abadin Salimi, invited half a dozen teenage girls to chat with me one evening. Sitting on the floor of Salimi's home, the young women said they wanted to retain Iranian and Islamic traditions, such as tightly knit families and respect for elders, but the theocracy's steady drumbeat of anti-American propaganda had done little to blunt their keen interest in the West.

When I asked one of them, an 18-year-old teacher who declined to give her name, what appealed to her about life in America, she talked of the freedom to enjoy simple pleasures in mixed company. "Things like riding a bicycle or swimming," she said. "We have wishes for enjoyment and a different lifestyle, but with this government we can't achieve them."

Throughout the country, state-controlled radio and television do their best to weed out "corrupting" Western influences. But the Internet and surreptitious satellite dishes are beginning to shred the Islamic curtain with which the authorities have sought to shield Iran.

Interest in the West has also been heightened by the close contact between Iran and its diaspora. An estimated one million Iranians, many of whom fled after the revolution, now live in the U.S., Canada, and Europe. I saw the effect of these expatriates at a wedding one evening in a middle-class neighborhood in Tehran.

A dark-eyed beauty of 22 named Toktam, wearing a bare-shouldered, Western-style wedding dress, was marrying 31-year-old Hossein, who runs a rental-car agency. Her family had lived for years in San Jose, California, and the ceremony, attended by several dozen guests, was a blend of American and Persian traditions. A mullah read the vows to the couple as older women in chadors looked on. But before the ceremony the mullah had to avert his eyes from female guests who were dancing provocatively in sexy gowns.

For sheer brazenness, none of the women could match Toktam's 18-year-old sister, Azadeh, who had long dark hair and black eyes. Azadeh, whose name means "freedom" in Persian, spent the first 12 years of her life in

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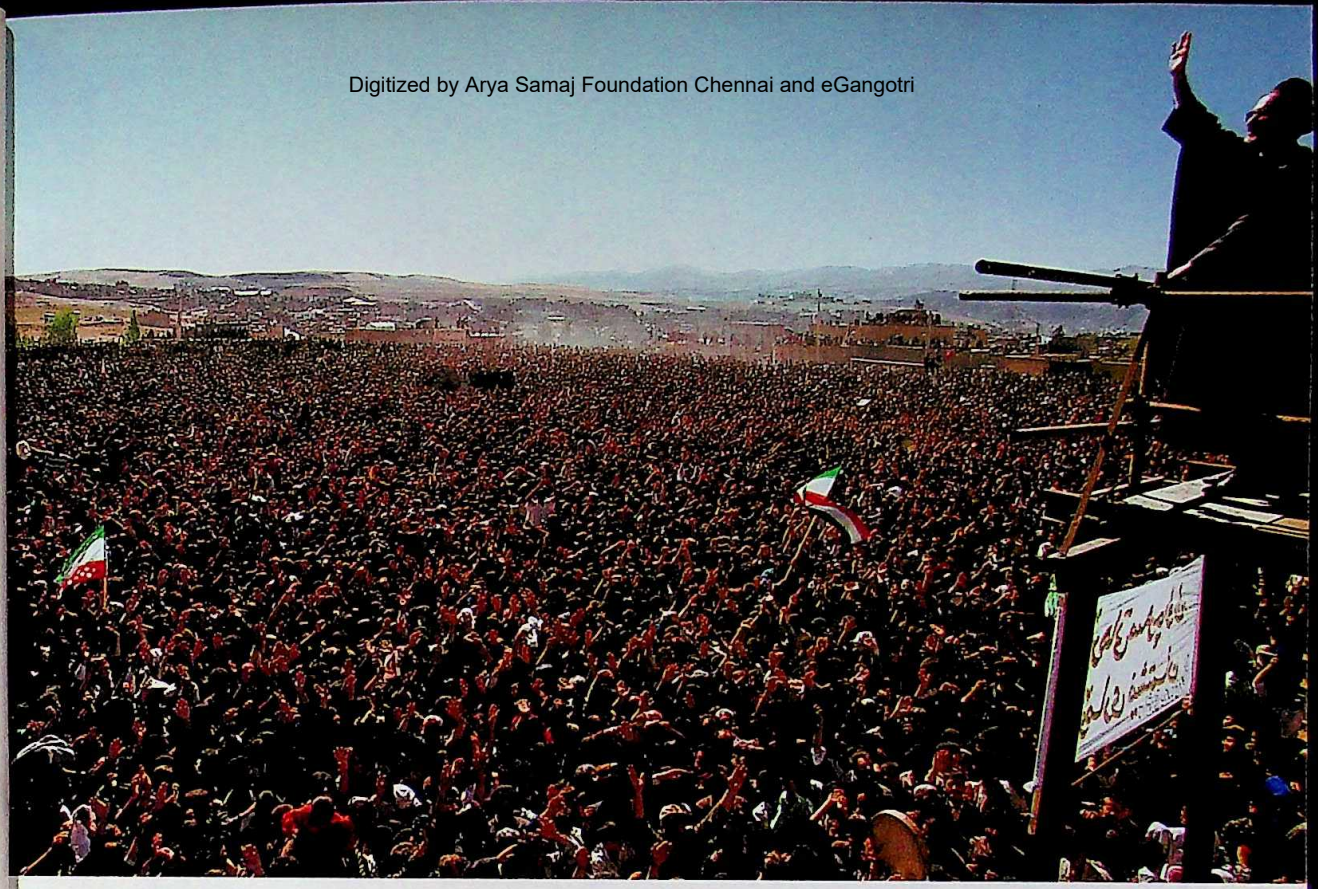
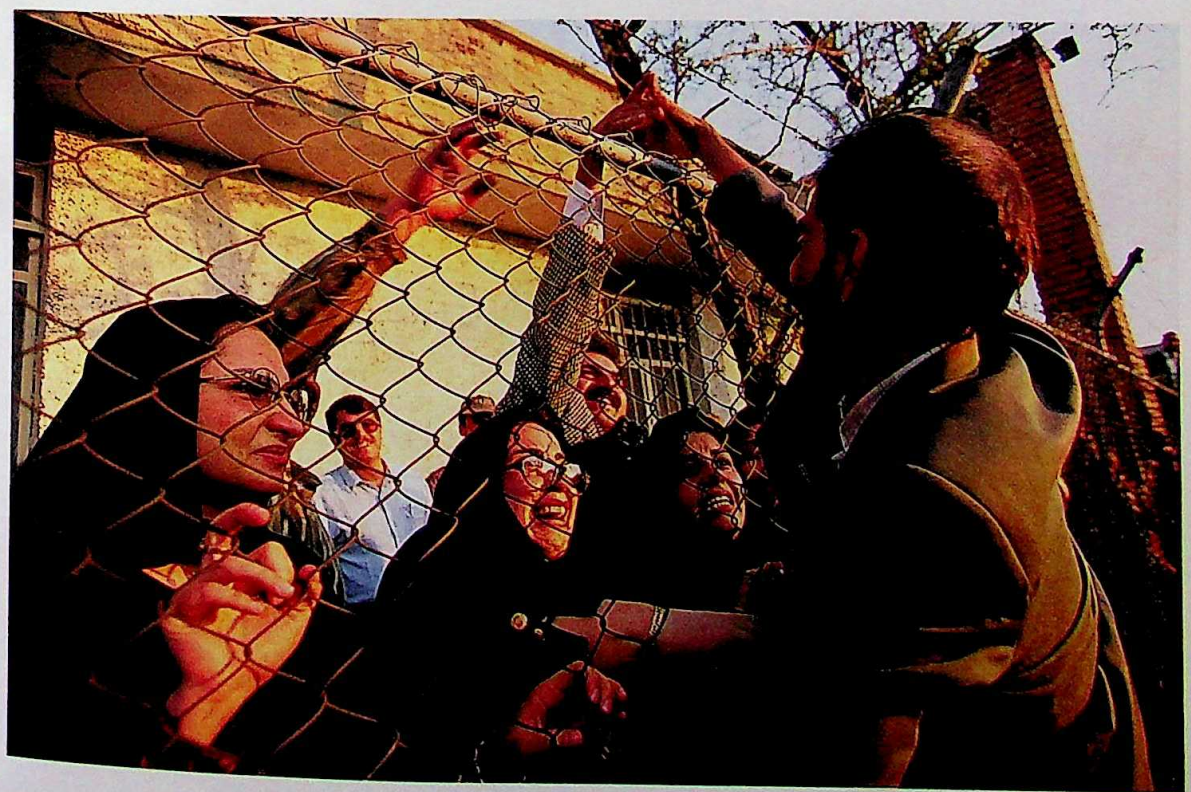


On a goodwill mission *President Khatami addresses a gathering of Kurds (above), whose separatist yearnings have long been repressed by the Iranian government. To its credit, Iran has accepted thousands of Kurd refugees from its erstwhile foe, Iraq. Finally greeting loved ones at Tehran's airport, a former prisoner of war (below) is one of hundreds that Iran and Iraq exchanged in 1998, ten years after their war's end.*



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Men and women *mix openly on the slopes of Shemshak, a ski resort in the Elburz Mountains.*

tains. *At the less liberal Dizin resort, morality enforcers insist that the two sexes ski on separate slopes.*

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northern California. She wore a tight, royal blue dress that spectacularly violated the Islamic dictum against showing curves. Dancing around the room, she showed a lack of inhibition that seemed, well, un-Persian. She told me she chafed under the restrictions of the Islamic government and had been a rebel at her all-girls school in Tehran.

"I don't like it here . . . I can't wait to go back to America," said Azadeh. "You can't walk down the street without someone bothering you. How can you be a teenager here? You're always 50 or over. . . . I'm really trying to take the best of American culture, like being honest and direct, and mix it with the best of Iranian culture, like the way families are so close, and become a better person." In the authoritarian atmosphere of Iran, Azadeh was a fresh breeze of freedom and irreverence.

Young women like Azadeh demonstrate that patience with the sexually discriminatory laws of the Islamic republic is dwindling. Women's rights advocates say inequities still exist in Iranian family law, citing statutes that allow a man to have several wives and to divorce more easily than a woman and that give fathers preference in custody battles. Despite the constraints, women are more integrated into Iranian society today than they were under the shah, mostly because higher education is more accessible.

Iranian women are, in fact, among the most educated and accomplished in the Muslim world. Before the revolution 35 percent of women were literate; now the rate stands at 74 percent. In the shah's time about a third of university students were women; now women make up fully half of new admissions. Better education is paying off professionally: Today one in three Iranian physicians is a woman.

Shireen Ebadi, a lawyer and former judge, whom I met in her office in central Tehran, explained this seemingly paradoxical progress. "Before the revolution many traditional women would not go to university or work. But because the revolution made these places so accessible, conservative families let their daughters go to university and into the workplace." But this had an unintended consequence. "With the revolution, many women came out of the kitchen. Women who emerge into society cannot be oppressed anymore."

Iranian women have indeed begun testing the limits of freedom. Women are still required by law to observe the *hejab,* the Islamic dress code, by covering their hair and the curves of their bodies. But in Tehran and other cities it is now common to see young women showing hair under their scarves and wearing makeup.

In the hinterland, where the roots of Islam go deepest, women are emerging more slowly. Climbing above the scorching plain of the Dasht-e Kavir, I visited Khvor, an emerald green oasis of plum, apricot, and walnut trees tucked into the folds of the barren, dusty brown mountains. Other than its renowned orchards and walnut crop, Khvor's mainstay is carpet weaving.

In one house I watched as Tahereh Salmani, 20, and her two sisters, ages 16 and 17, wove a carpet. Sitting erect behind the vertical carpet frame, Tahereh—who has been weaving since she was 11—deftly threaded wool through the string guides and fired off instructions to her sisters. Asked how she liked her work, Tahereh, who wore glasses and a white print chador, replied, "If we didn't like it, we wouldn't do it."

In nearly every household in Khvor young women like Tahereh make carpets to sell to dealers in nearby Tabas. The carpets usually bring from $300 to $1,000, a handsome sum in a place where the average monthly income is less than $150. The village school ends at fifth grade, which is when most girls drop out to begin weaving. While some families send their sons to middle school in Tabas, they prefer to keep their daughters at home under sheltering parental wings.

Standing beside the girls was their father, Mohammad Salmani, a balding, retired laborer dressed in a T-shirt and baggy trousers. He has ten children, so the extra money his daughters make is important. He said he will use it to help pay their dowries, which could amount to $2,000 each. "They are the hardest working girls in the village," he said proudly.

No matter where you go in Iran, people seem preoccupied with making ends meet. Leaving the desert, Mostofi and I headed to the Caspian Sea plain on the north side of the Elburz Mountains. After the scrubby, khaki-colored vistas of the desert, it was a relief to be in a forested landscape once again.

Driving past brilliant green rice fields, we saw a man the width of a door puttering down the road on a motorcycle, the back of which

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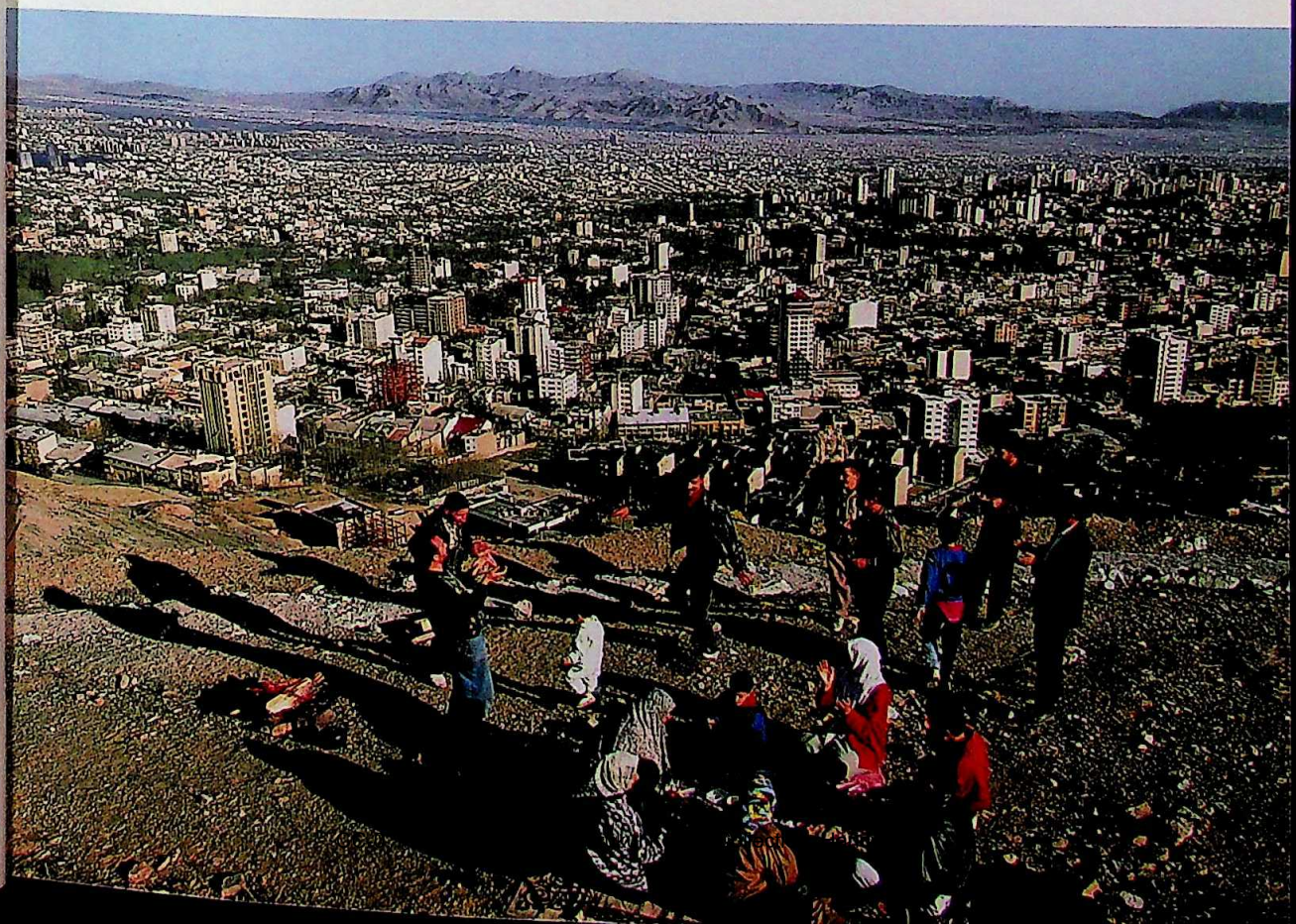
Behind closed doors *morals become personal. At a wedding party in Tehran, guests of the Iranian-American bride remove their veils and dance, while the groom's more conservative kin remain covered and still. High above Tehran (below), a family celebrates the 13th day of No Ruz the traditional way: outdoors. Throughout the year city dwellers head for the hills to seek refuge from smog and scrutiny.*



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Diverse Faiths

Lamb's blood (above) commemorates the A.D. 680 martyrdom of Imam Husayn, a figure revered by Iran's Shiite Muslim majority. Iran is more tolerant of religious minorities than many Mideast countries, attested by the presence of synagogues where Jews instruct their children (top right) and temples in which Zoroastrians practice their ancient Persian faith (right). But human rights groups charge Iran's Shiite government with violating its own constitution by subjecting non-Muslims to varying degrees of discrimination and persecution. The most egregious cases involve devotees of the Baha'i faith, considered heretics, and evangelical Christians, distrusted for their ties to churches in the West.

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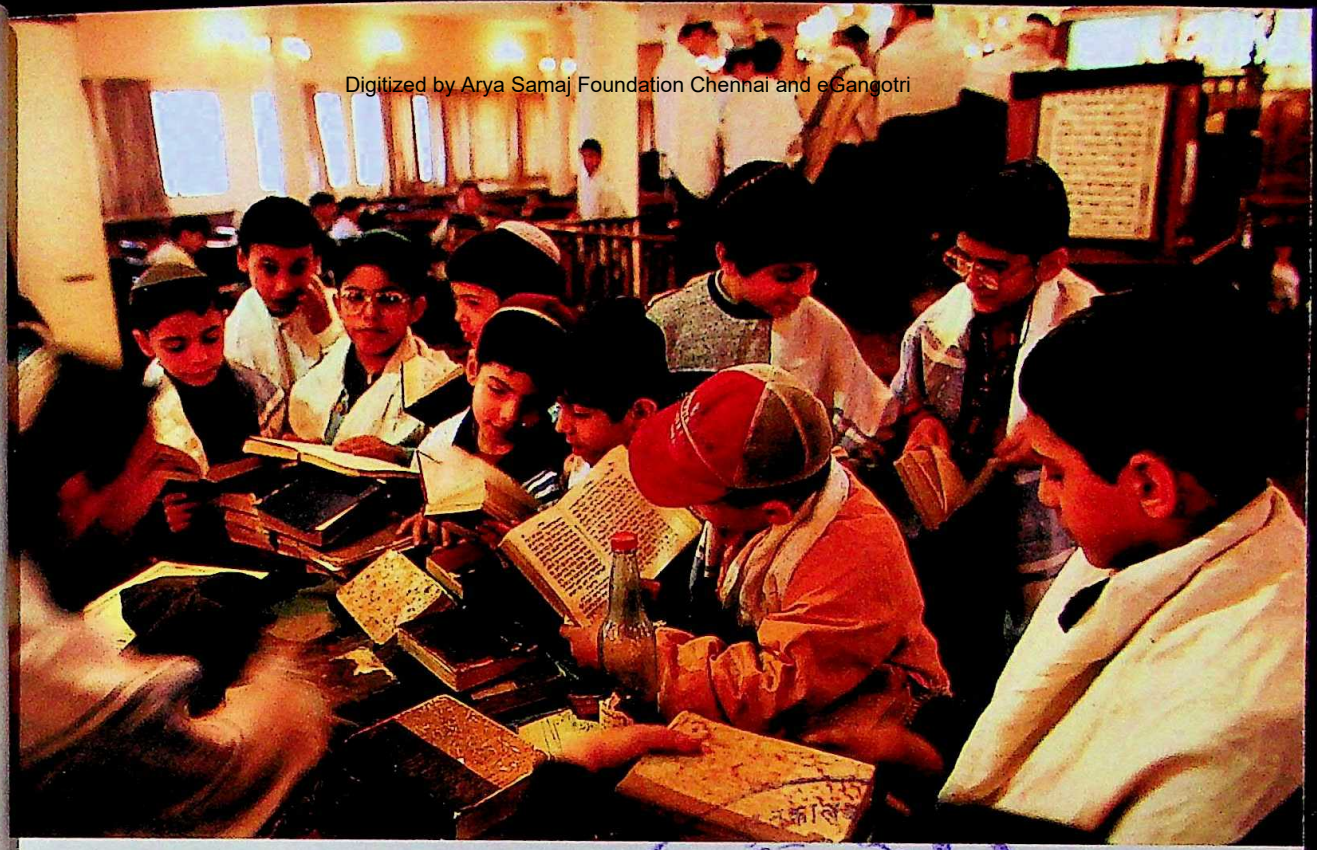

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was piled high with leafy branches. "Mulberry leaves," said Mostofi. "Food for his silkworms."

The motorcyclist's name was Ali Akbar Shafei, and with his permission we followed him to his home in Now Deh, a village of brick and concrete houses set on winding streets in the foothills of the Elburz.

Shafei, a 32-year-old whose 220-pound body, fierce black mustache, and week-old stubble belied a gentle disposition, pulled into his courtyard and hauled the pile of branches into a room attached to his brick house. There he was fattening up 20,000 white silkworms, whose cocoons would produce fibers for carpets and textiles. He would sell the silkworms to a local middleman, netting about 500,000 rials, roughly $165. Not a bad sideline for a man who earns about a hundred dollars a month as a security guard and who grows half a ton of rice a year to help feed his family.

"I cope, I survive," said Shafei, who has a wife and two children, as we sat on his front stoop drinking tea. "I live in a village and it's cheap, but you couldn't survive without growing something. Inflation is just killing us. It's crushing us. We don't save anything."

At the time we spoke, inflation was running around 20 percent a year. Falling oil prices

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A mirror's many facets *reflect a uniform reality in Qom, where women approach their entrance to a shrine. With some 30,000 theology students, Qom has supplanted An Najaf, Iraq, as the world's center of Shiite scholarship.*

(from $36 a barrel in 1981 to about $11 in 1998) and production problems in Iran have caused a slide in oil revenue from 22 billion dollars in 1976 to 10 billion in 1998—a huge setback considering that oil is Iran's number one source of export earnings.

Since the inception of the Islamic republic the economy has suffered other blows as well: the flight of many of the country's business and technical elite, the protracted war with Iraq, trade sanctions by the U.S., a doubling of the population. The regime worsened matters by nationalizing all the major industries; spending more than 11 billion dollars a year to subsidize the prices of gasoline, bread, and electricity; discouraging foreign investment by confiscating businesses; and allowing shady government foundations to dominate such important areas as real estate.

President Khatami's allies say he understands the need for reforms, but it's a huge challenge in a country riven by ideological splits and ruled by clerics with little understanding of economics. In late 1998 his government proposed raising the price of state-subsidized gasoline, which, at 12 cents a gallon, is the world's cheapest. That proposal was shot down by the conservative parliament, which preferred to continue popular policies.

As a result of all this, families like the Shafeis are having to make do with less. The average income of Iranians in 1999 dollars has fallen from about $2,600 in 1976 to $1,800 today. Even so, Iran is not an impoverished nation. Indeed Iranians have a living standard many times higher than those of their central and south Asian neighbors, such as Pakistan, Afghanistan, and India.

While the ailing economy and heavy-handed religious rule have eroded support for the supreme leader, Ali Khamenei, he retains a core of ardent followers. This conservative bulwark is closely tied to several phenomena: devout Muslim faith, continuing belief in the revolution, and the war with Iraq.

To feel the fire of devotion to the regime, one need only visit Khorramshahr on the Iraqi border. The city suffered more than any other during the war, which began on September 22, 1980, when Saddam Hussein invaded Iran to reclaim what he contended was Iraqi territory. The war dragged on for eight years, killing an estimated million people all told.

Near the northern end of town, close to the Shatt al Arab waterway—the border with Iraq—is a neighborhood where date palms once grew in profusion among the mud and brick houses. Flattened during the war, the palm trees and old houses have been replaced by rows of two-story, beige stucco apartments.

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Such rebuilding has encouraged people to return to the city, and the population is climbing back toward its pre-war level of 150,000.

Habib Eqbalpour, 70, and his wife, Zinat Parvaresh, 63, live in one of the new apartments. Two of their sons were killed fighting in and around Khorramshahr, and they spoke with passion about the martyrdom of their boys in defense of the Islamic republic.

"We are proud we lost our children, Allah be praised," said Mrs. Parvaresh, pulling a black chador over her chin as we sat on the carpeted floor of their living room. "We hold our heads high, thanks be to Allah."

They likened their sons to Imam Husayn, the grandson of the Prophet Muhammad. Husayn is central to the religious fervor of many Iranians, some 90 percent of whom are members of the Shiite branch of Islam, not the Sunni one, which predominates in the rest of the Muslim world. In A.D. 680 thousands of Sunni warriors from present-day Syria killed Husayn and scores of his followers at Karbala, in what is now Iraq. The battle deepened the schism between Shiite and Sunni Islam, and to this day the martyrdom of Imam Husayn inspires in devout Iranian Shiites a sense of the nobility of sacrifice in the face of oppression and threats to the motherland.

"My sons are following in the path of Imam Husayn, and when they are in the other world, they are helped by Imam Husayn," said Mrs. Parvaresh, whose boys were 17 and 21 when they died. Because of the family's loss, government foundations, including the Martyrs' Foundation, provide them with a free apartment and pay them a stipend of 360,000 rials a month (about $120).

THE WAR is still a palpable presence in Iran: Thousands of city streets are named after martyred soldiers, martyrs' cemeteries with flapping green-and-red flags (green is the color of Islam and red signifies the martyrs' blood) exist in virtually every village, and gigantic murals of well-known martyrs are painted on billboards throughout the country. Every year in observance of the martyrdom of Imam Husayn, Iran marks Muharram, a month of mourning in which people march through towns and cities, flaying themselves with chains and reciting tales of the nobility of his sacrifice.

I was in Isfahan for Ashura—the tenth day of the month, marking the moment of Husayn's death—when the ceremonies became a pep rally to cheer conservative political forces and attack the United States. The focus of Ashura in Isfahan is Imam Khomeini Square, a stately quadrangle flanked by several great monuments of Persian architecture. Among them is the Imam Mosque, completed in 1638, which rises above the low-slung skyline of central Isfahan, its cerulean dome and beige trim matching the desert sky and sand.

Thousands of mourners filed through the square, including members of the Revolutionary Guard. Barefoot, many of them wearing the red-and-green bandannas signifying their desire to make the ultimate sacrifice for Islam, the mourners trotted en masse past the reviewing stand, chanting and pounding their chests. Standing just a few feet from these die-hard defenders of the republic, feeling the concussive thump of hundreds of fists on chests, I felt a wave of awe—and fear—run through me.

The speaker, referring to the American and Western culture that was creeping back into Iran, praised the demonstrators and declared, "These are fighters for Islam! Yesterday they were at the war front fighting the enemy. Today they are fighting a cultural invasion!"

The bearded men ran in rows through the square. "We are going to blind those who love the United States," they chanted.

The zealotry was an unnerving reminder of the Iran that President Khatami seeks to moderate. As the men filed out of the square, I hurried after them, wanting to find out if their personal opinions were as fierce as their public slogans.

"Whenever relations between a wolf and a sheep become good, then we can have good relations with the United States," Hamid Reza Salimian, a 30-year-old computer technician, said, as his cohorts nodded in assent and pressed in on me. One man warned me not to twist what they were saying; others heaped scorn on the U.S. government. Quietly my translator urged me to leave, and we squeezed through the marchers and disappeared into Imam Khomeini Square.

A few miles from ancient Persepolis in rural Fars Province, Behnam Fallahi and other farmers pay little heed to demonstrations in Isfahan or nearby Shiraz. *(Continued on page 30)*

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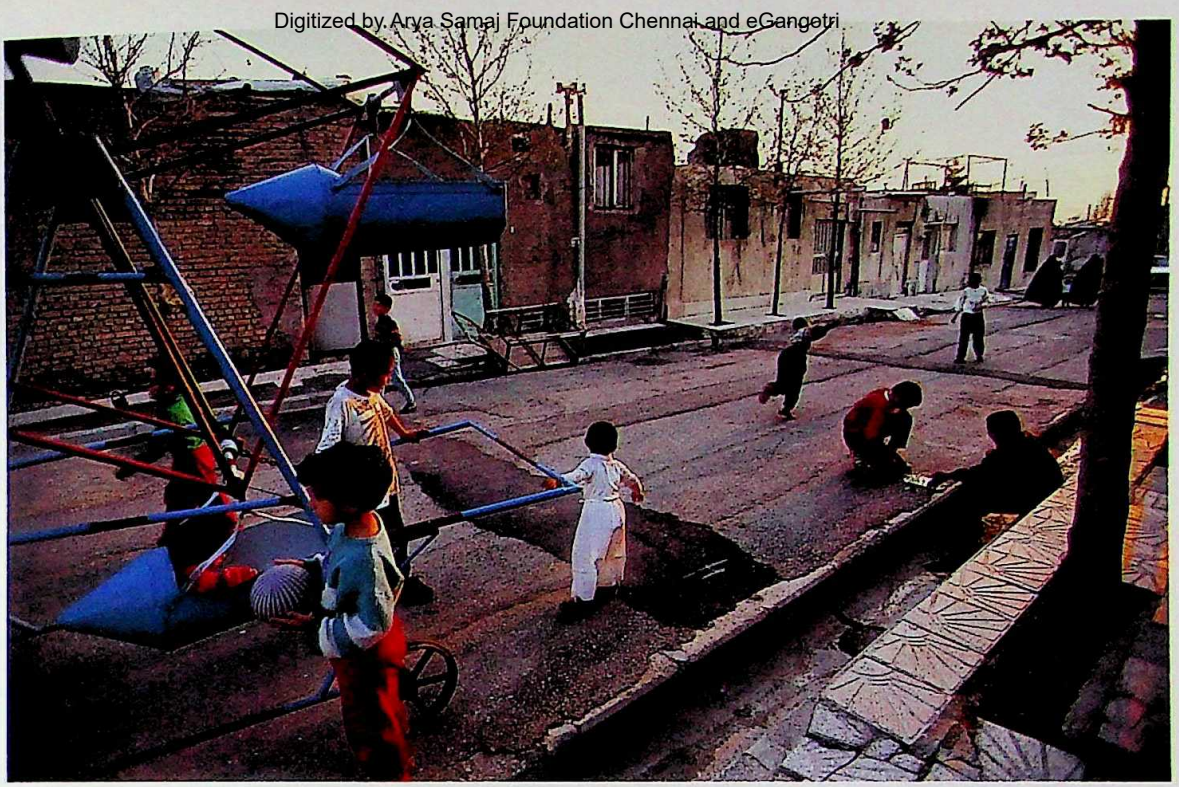

A clean street *makes a lively playground in south Tehran (above), but poverty is close at hand. Inflation and unemployment in Iran run around 20 percent. In the southwestern province of Khuzestan (below), Nahid and Hussein Saboee collect salt after school to sell to bakers. The good news: 85 percent of Iran's children go to school, and 80 percent of the population is literate, versus less than half before the 1979 revolution.*

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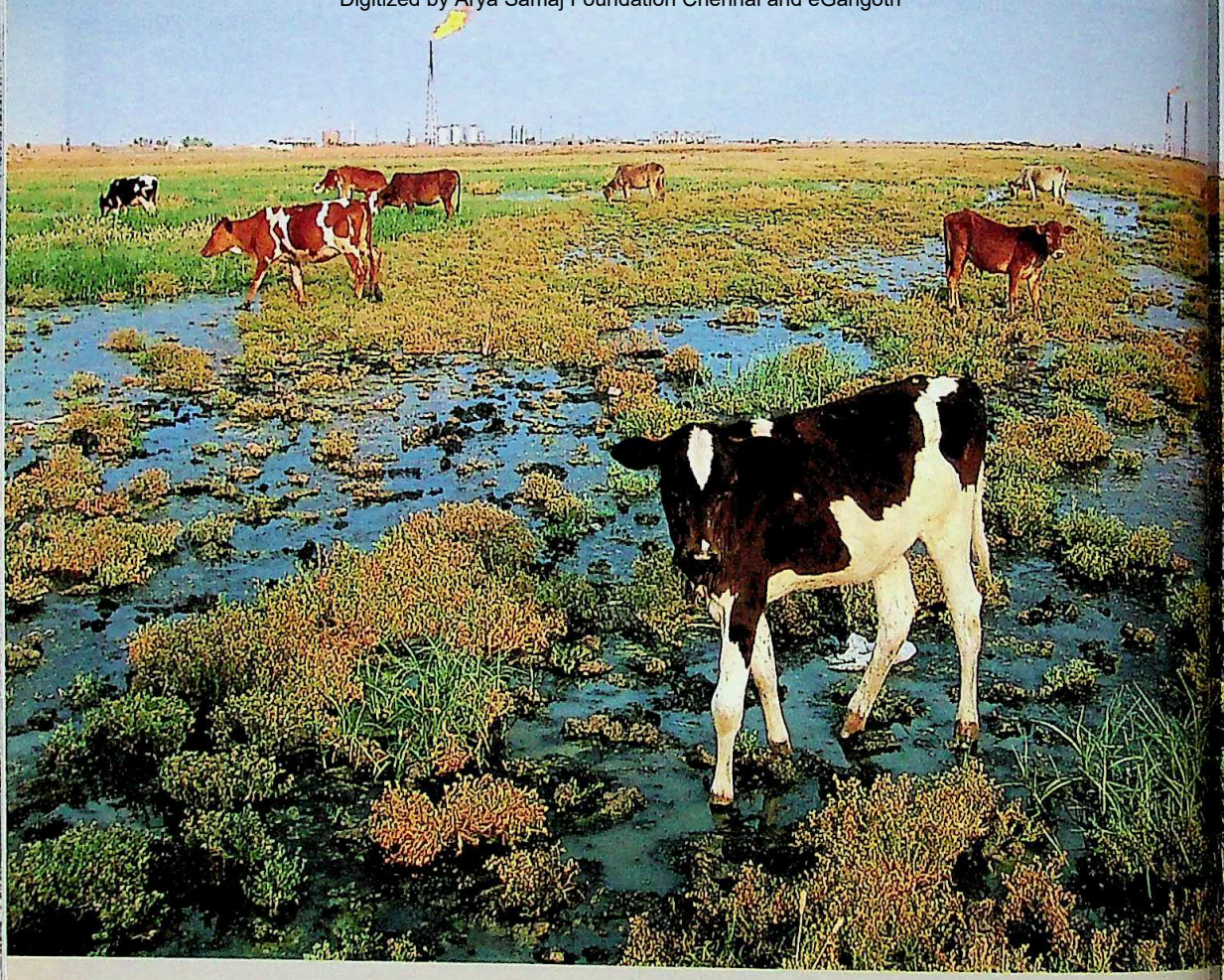

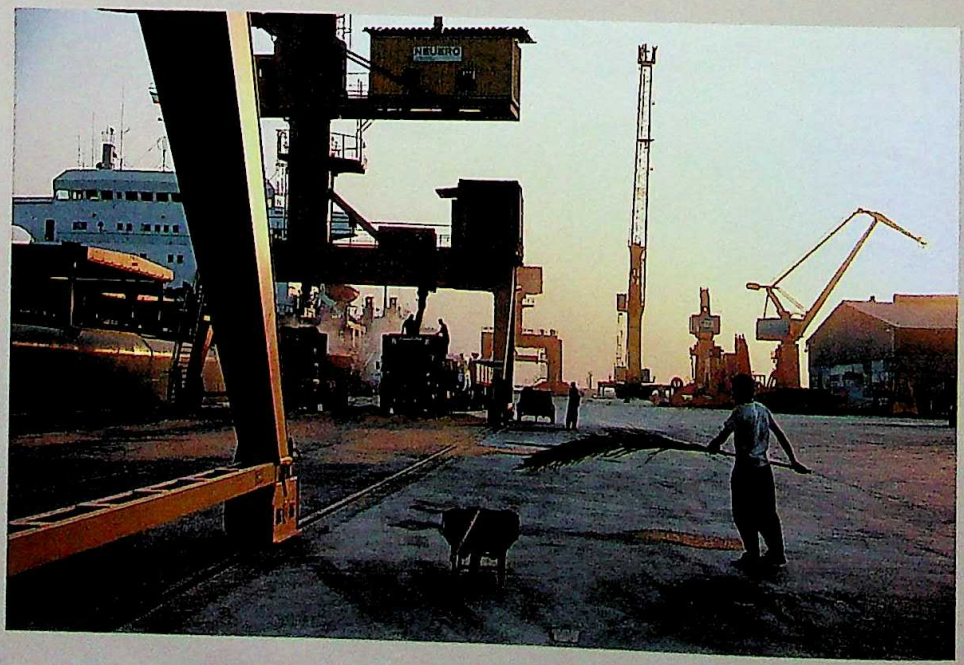

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An Economy at Low Ebb

Iran has 9 percent of the world's proven oil reserves, most of it in Khuzestan (left), a primary target of Iraq during the eight-year war. Iran depends on oil for 80 to 85 percent of its export earnings, and as prices have fallen through much of the 1990s, its economy has struggled to stay afloat. Famed Persian carpets help, as do pistachios, the third largest export. Despite increasing competition, Iran remains the world's largest producer of the nuts—many grown in Rafsanjan (below). Iran is hoping to encourage fresh markets by developing a new "silk road," a rail line between Central Asia and Iranian ports on the Persian Gulf, such as Bandar-e Abbas (bottom left).

Public Dom Col ridwar

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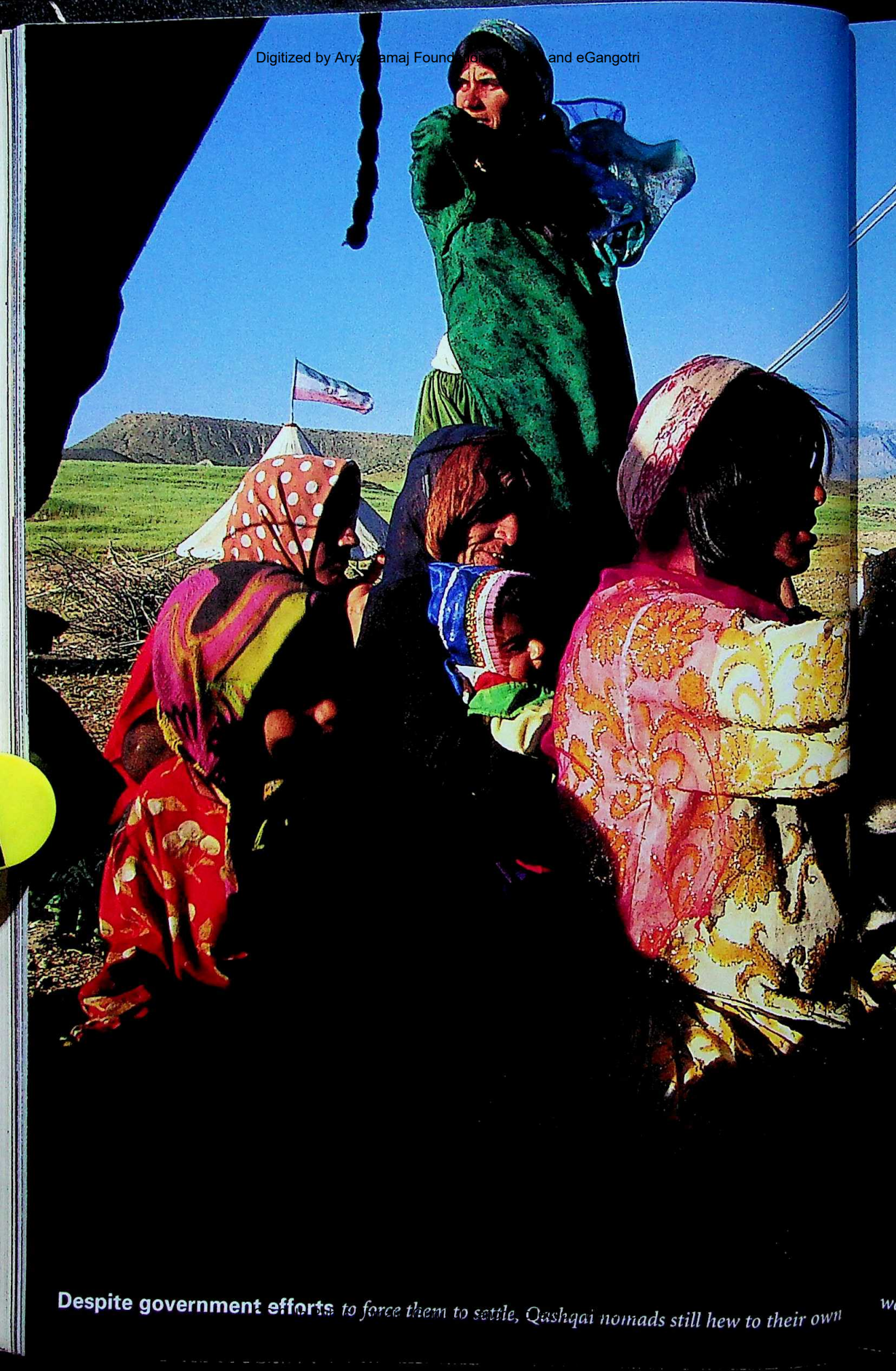

Despite government efforts *to force them to settle, Qashqai nomads still hew to their own*

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r own ways. Thousands roam Iran's southwest, tending sheep and goats and spinning wool for carpets.

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(Continued from page 24) In the shadow of high brown cliffs where ancient Persians left carvings of battles fought against Roman invaders, farmers toil to produce the 25 or 30 tons of wheat needed to support their families from one year to the next.

When I met Fallahi, a slight man of 27 in mud-splattered clothes, he and two other farmers were clearing debris from irrigation channels in a plot the size of several football fields. As we talked, a hot, dry wind rippled the wheat. "It's 100 percent better now," he said. "We can decide things for ourselves, talk for ourselves. In the old days nobody could say anything. They were really under pressure from the landlords."

He was referring to the landed aristocracy, which until the 1960s ruled Iran like a fiefdom, with prominent families owning entire villages. The last shah began a major land redistribution, and after the revolution the Islamic authorities continued to break up large properties and give the land to peasants.

Other changes are visible throughout the wide, irrigated desert valleys, dotted with buttes and flanked by rocky slopes. Nearly every village has new paved roads or telephone lines, electricity or irrigation pumps—all part of a program for rural areas under the auspices of a government ministry called the Crusade for Construction.

In Shiraz the head of the Fars Province branch, Abdul Karim Razavi, ticked off the accomplishments of the Islamic republic. In Fars the regime has paved 1,631 miles of roads, graded 2,463 miles of dirt roads, built 4,465 feet of bridges, installed new drinking water systems in 1,340 villages, and increased the number of villages with electricity from 324 to 2,044—89 percent of the rural population. These gains, he said, are representative of progress throughout Iran.

"Before the revolution we can say that the government led from the top down," said Razavi, who wore the look preferred by officials—neatly trimmed beard, dark suit coat, no tie. "Now people participate. Before, people living in rural areas thought they should migrate to the cities. It wasn't economical to stay in villages. Now it is."

One reason life is better in the countryside is that the Islamic republic has managed to slow a population boom that has severely strained the country's social and economic fabric. After 1979 the regime exhorted people to reproduce for the motherland. The average Iranian woman had six children, and the country was growing by more than a million a year. Today, thanks to public education, free contraceptives, and publicity campaigns emphasizing the advantages of having fewer children, family size has been halved. (At the same time life expectancy has risen from 60 to 72 years, and infant mortality has been reduced from 90 deaths per 1,000 births to 26.)

"Each Muslim has the right to good health care and proper food, clothing, and education," said Mohammad Ansari, the physician at a health clinic in Segzi, a small town near Isfahan. "If people with large families are not in a position to provide those, then we need family planning." Ansari invoked the words of Imam Ali, son-in-law of the Prophet Muhammad. "He himself said that the fewer the children, the more peace of mind."

THE INVOCATION of an ancient Islamic figure to further the modern goal of population control is but one example of how the current regime is attempting to reconcile the old and the new, the religious and the secular.

Further evidence of this can be seen at Qom, home of a renowned religious seminary where Ayatollah Khomeini and many of Iran's religious leaders studied. There, amid the tranquil turquoise-and-green mosaic-tile seminary buildings and gold-domed mosques is an incongruous operation: the Computer Research Center of Islamic Sciences.

"Islam encourages us to use technology and knowledge," said Assadollah Moslemifar, the deputy director of the center. He accompanied me to a long basement room where turbaned scholars and students sat behind banks of computers, dissecting holy texts using Windows 95 or training to become software engineers. The center's staff members, all mullahs, produce illustrated CD-ROMs of the Koran and other religious products, which are sold worldwide.

"With the Internet all human beings will improve themselves," said Moslemifar. "I think there are ways to avoid corruption on the Internet and take the positive points." The government permits numerous companies to provide citizens with access to the Internet

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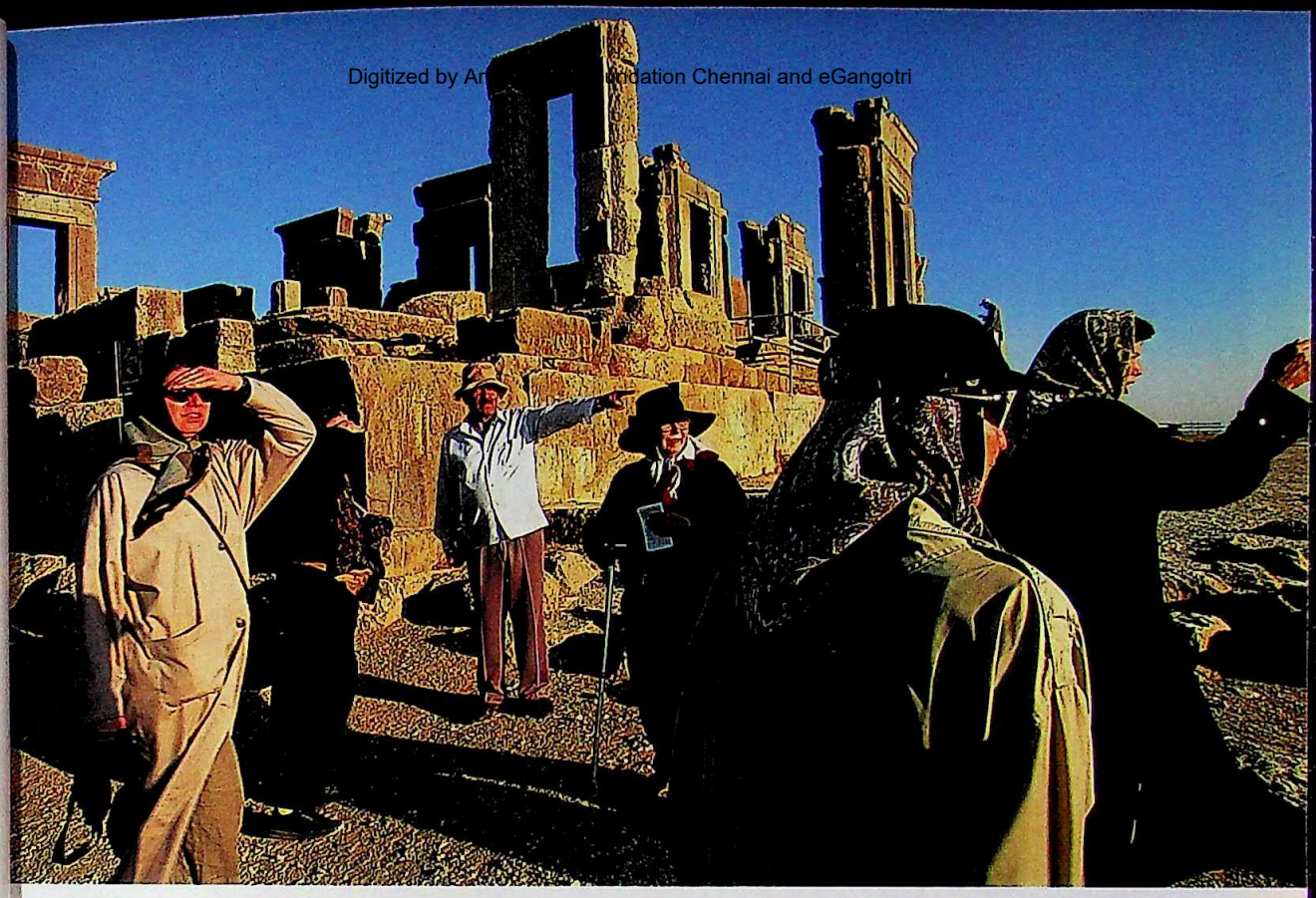

American tourists *again revel in ancient Persepolis (above) and rave about their welcome across Iran. Most Iranians dismiss "Great Satan" rhetoric, and even some demonstrators try to soften it. For 1998's anniversary of the U.S. embassy takeover, students planned to burn an Uncle Sam puppet instead of an American flag—to bash America's government, not its people. But diehards won out and Old Glory burned.*

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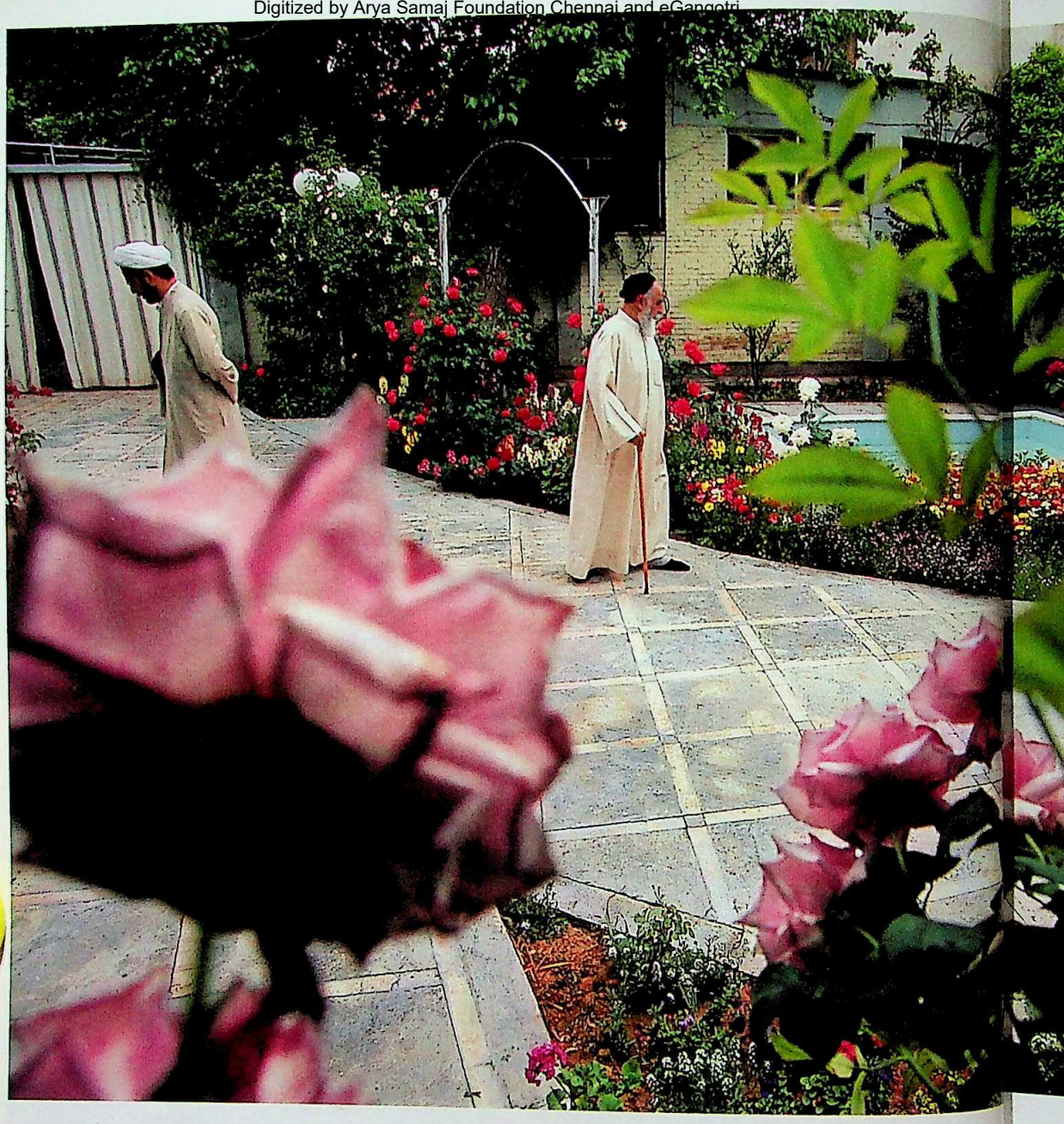

but requires that sites deemed unsuitable be blocked, an increasingly difficult task.

Outside, in the seminary courtyard, I met a young man who was undergoing the rigorous course of religious education, which can take a dozen years. He was sitting on a stone wall in the shade of a eucalyptus tree.

Ali Safaryan, a tall 26-year-old with gold-rimmed spectacles and a gray robe, said he was a student of Islamic law. He spoke forthrightly of his belief that the revolution has made Iran truly independent of foreign powers.

"I prefer to live one hour in this era than a lifetime before the revolution." Bracing myself for a revolutionary harangue, I was taken aback by Safaryan's answer when I asked him about President Khatami.

"He is ideal in all respects. He talks about Islamic democracy. He brings us this gift of dialogue between cultures. And he has improved the view Iranians have of Americans."

Safaryan sought to minimize the tug between the forces of reform and reaction, contending that a majority still supports the basic ideals of a theocracy. Back in Tehran, Ibrahim Yazdi, head of the opposition Freedom Movement of Iran, said the country's political forces now find themselves in a healthy stalemate.

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In Shiraz, *famous for its gardens, Ayatollah Majdeddin Mahallati earns respect not with proclamations but with charitable projects like orphanages. Iranians value such practical piety and hope for a new flowering of tolerance.*

"In Iran no single faction can annihilate the competition," said Yazdi. "This is a very promising situation. This is the progress of democracy. You have a delicate balance of power."

On May 23, 1998, the first anniversary of Mohammad Khatami's election, the soft-spoken president and tens of thousands of his supporters—most of them young, many of them women—took part in a rally unlike any seen in Tehran in the two decades of the ayatollahs' rule. This time no one burned Uncle Sam in effigy. Instead the marchers flowed down Vali-ye-Asr street under the shade of the plane trees calling for an end to the religious regime's stranglehold on power.

"The enemy of our society is prejudice and monopoly," shouted a line of young women in long black chadors. Demonstrators carried banners reading "Freedom of the Press," "The Military Should Be Reformed," "Freedom of Thought Is Everybody's Right."

Onlookers stood on balconies and in shop doorways, many of them nodding or smiling in approval. As I hustled alongside the rows of marchers, listening to the chanting and taking in the expressions of hope and excitement on the demonstrators' faces, I was reminded of the pro-democracy, anti-communist marches I had witnessed in Moscow in the waning years of the Soviet Union.

The marchers converged on the Friday Prayer pavilion at Tehran University, a place where Iran's revolutionary leaders have traditionally spit fire and led chants of "Death to America." Khatami, dressed in a light gray robe, black loafers, and the black turban that marks him as a descendant of the Prophet Muhammad, faced a crowd that spilled out from under the pavilion and onto nearby sidewalks and streets. For more than five minutes his supporters whistled and cheered and pumped their fists in the air. At last Khatami succeeded in quieting them.

"The future of religion is that it has to cope with freedom; otherwise it has no future," he told the crowd. "If religion confronts freedom, then religion will suffer."

As he continued speaking, a small group began chanting "Death to America!" They were soon drowned out by louder chants of "Death to Monopoly!" For a moment Khatami stood quietly, the late afternoon sun filtering in golden shafts onto the speaker's platform. Then he uttered a remark that silenced everybody. "I prefer," said the President of Iran, "to talk about life, not death." □

What does Iran's future hold? Share your thoughts online at *www.nationalgeographic.com/ngm/9907*. Also tune in to "Iran: Behind the Veil," airing July 28 on National Geographic EXPLORER.

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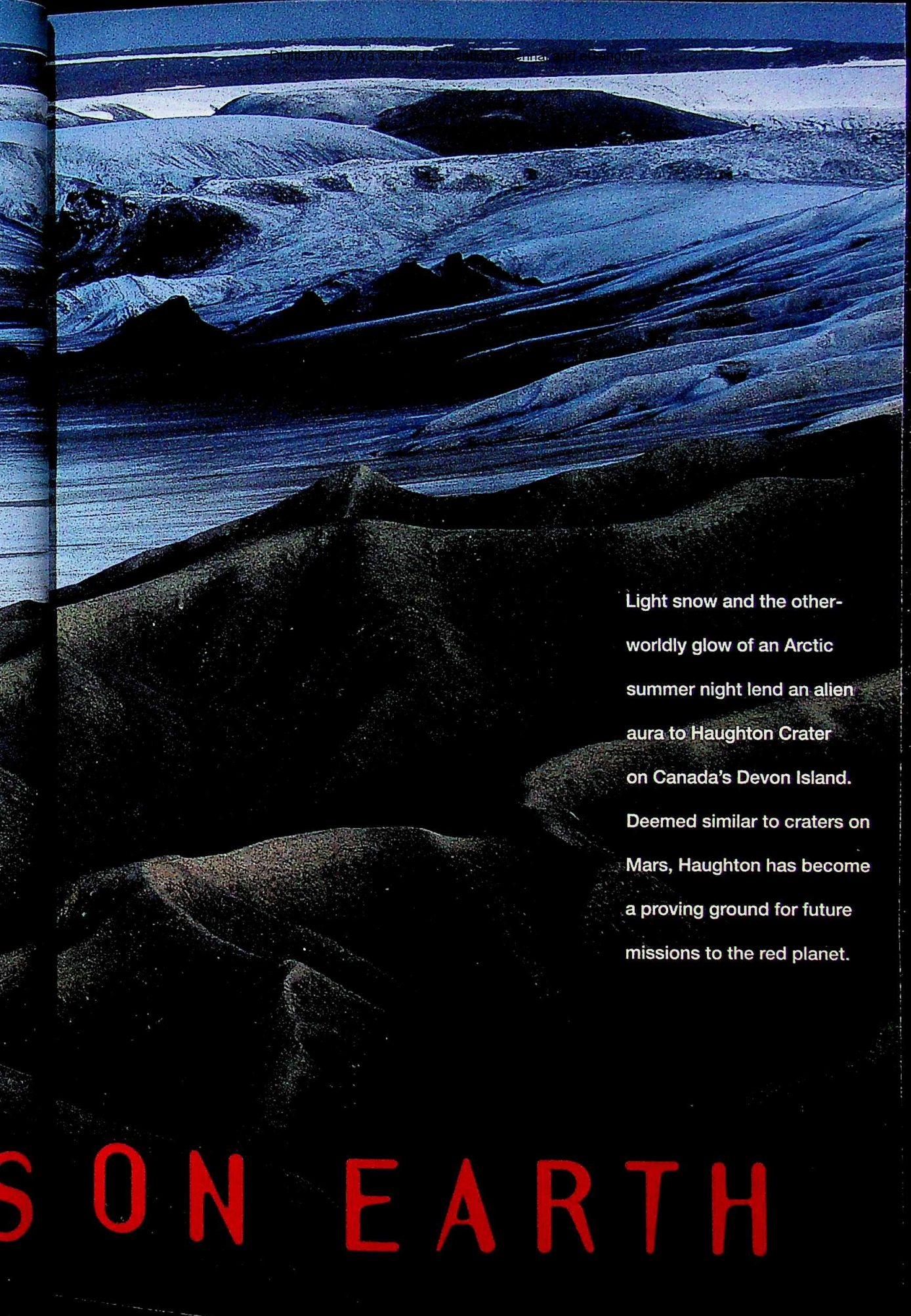

Light snow and the other-worldly glow of an Arctic summer night lend an alien aura to Haughton Crater on Canada's Devon Island. Deemed similar to craters on Mars, Haughton has become a proving ground for future missions to the red planet.

S ON EARTH

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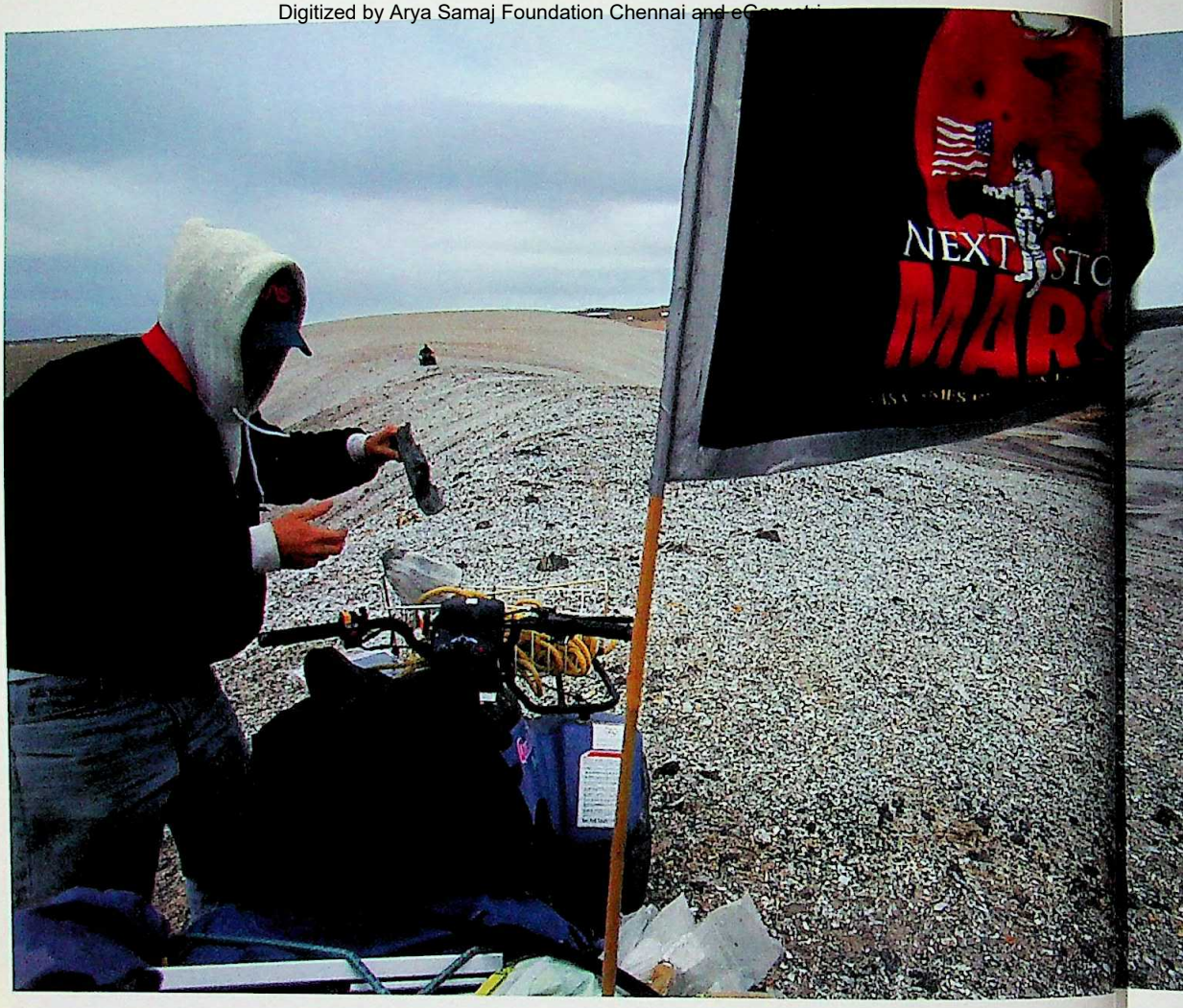

By **Michael E. Long** Photographs by **Peter Essick**

THE METEORITE slammed into the island in what is now the Canadian Arctic at 40,000 miles an hour. The resulting thousand-megaton blast of energy was nature's equivalent of a nuclear catastrophe.

Excavating a crater 15 miles wide, the explosion and shock wave pulverized the island's rocky innards, ejecting shards of dolomite, gneiss, and granite thousands of feet high, while ruptured mains of groundwater gushed into the depression. The rock rained down, accumulating into hills of jagged remnants called breccia. Hot breccia mixing with groundwater brewed cauldrons that boiled and hissed. Within a radius of perhaps a hundred miles, plant and animal life ceased to exist.

Twenty-three million years later Haughton Crater, named for an Arctic geologist, still pockmarks Devon Island on Lancaster Sound, the seaway of disappointment for 19th-century British mariners seeking a Northwest Passage. Devon is now populated by polar bears, musk oxen, caribou, arctic hares, and snow buntings. The crater's rim, worn like old molars, encircles the breccia hills and the ancient lake beds covered with hummocked tundra. Treeless, windswept, rock strewn, and otherworldly, the terrain is eerily akin, some experts believe, to that of craters on Mars.

Scientists, mostly from the National Aeronautics and Space Administration (NASA), are gathering here under the midnight sun of Arctic summer to examine Haughton Crater's rocks, drill into its lake-bed deposits, peer

No strangers to working in rugged terrain, writer MIKE LONG and photographer PETER ESSICK last teamed up to report on the Grand Canyon in the July 1997 issue.

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A fluttering banner heralds the goal of planetary scientist Pascal Lee, leader of two dozen researchers who spent a month last summer on Haughton's rocky hills. Dry, cold, and barren, the crater has been an ideal Mars stand-in for experiments in lake-bed core sampling, robotic mapping, ground-penetrating radar—even group dynamics. Says Lee, "Everybody feels like an astronaut here."

beneath its surface with radar, and conduct other experiments to assess the crater and its environs. They are preoccupied by two questions: What can Haughton tell us about water on Mars? About life on Mars?

At Resolute on nearby Cornwallis Island, I join a group of scientists boarding a de Havilland Twin Otter. Crammed with more than a ton of passengers and cargo, the twin-engine vaults into the air after a short takeoff roll and settles into the 45-minute flight to the crater. We pass over Devon's precipitous headlands and deep, fjordlike valleys, and we land beside the Haughton River on rock and gravel—no one would call this a runway—at camp.

RESEARCH PROJECT

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All pitch in to unload. Fuel drums are simply heaved out and crash to the ground. An all-terrain vehicle, or ATV, lands on its wheels and bounces, demonstrating its toughness. As I pitch my tent, I feel a profound sense of aloneness. We are 13 people on an island about the size of West Virginia.

After a pep talk from expedition leader Pascal Lee, a planetary scientist from NASA Ames Research Center near Mountain View, California, we proceed to camp routine. Geologist John Schutt briefs us on riding ATVs, our principal mode of transport, and how to handle a shotgun in the event of a polar bear incursion. Will lead slugs and buckshot stop the Arctic's largest carnivore?

I prefer to rely on our bear-early-warning dog, a massive half Saint Bernard, half husky named Bruno, veteran of several trips to the north magnetic pole and responsible for safeguarding skiers from bears. Last year he drove off a bear approaching this camp.

We squeeze into a 14-by-12-foot mess tent for dinner, sitting on freezer chests rimmed by giant cans of pork and beans, spaghetti, and chili plus jumbo cartons of tea, oatmeal, dried milk, and mashed potatoes. Geologist Jim Rice—6 feet 3 and 220 pounds—comes through the tent flap like a loose iceberg. Amid three long tables there is scant room to maneuver.

An adjacent tent of equal size is strewn with spaghetti bundles of wires, cords connecting to battery chargers, laptops that sit like opened clamshells, and other scientific paraphernalia.

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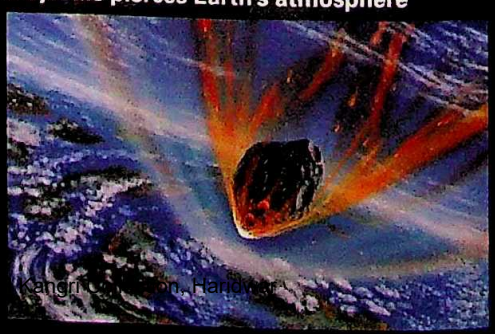
Twenty-three million years ago an asteroid or comet slammed Earth with such force that soil, sediment, and bedrock from more than half a mile underground shot skyward. The pulverized bits fell back to the ground as breccia, whose ash-gray signature marks Haughton Crater today (above). At the time of impact this was a warmer, lusher land of spruce and pine. The blow and its shock wave, heat, and debris left a 15-mile-wide crater surrounded by desolation. Groundwater immediately filled the bowl. Now dry and reduced to a 10-mile diameter by the rim's erosion, the crater lies in a polar desert, its sediments holding the secrets of a Miocene disaster.

Projectile pierces Earth's atmosphere



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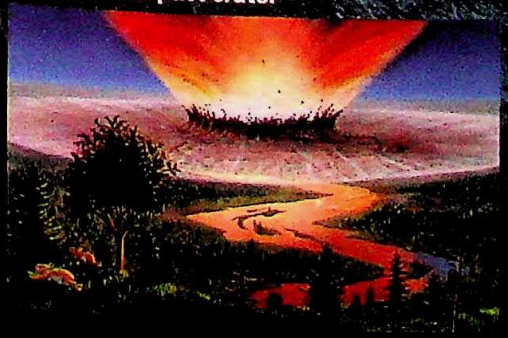
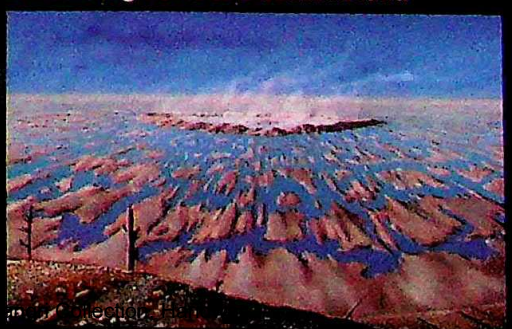
Birth of an impact crater



Smoldering heart of a battered land



ART BY MICHAEL CARROLL

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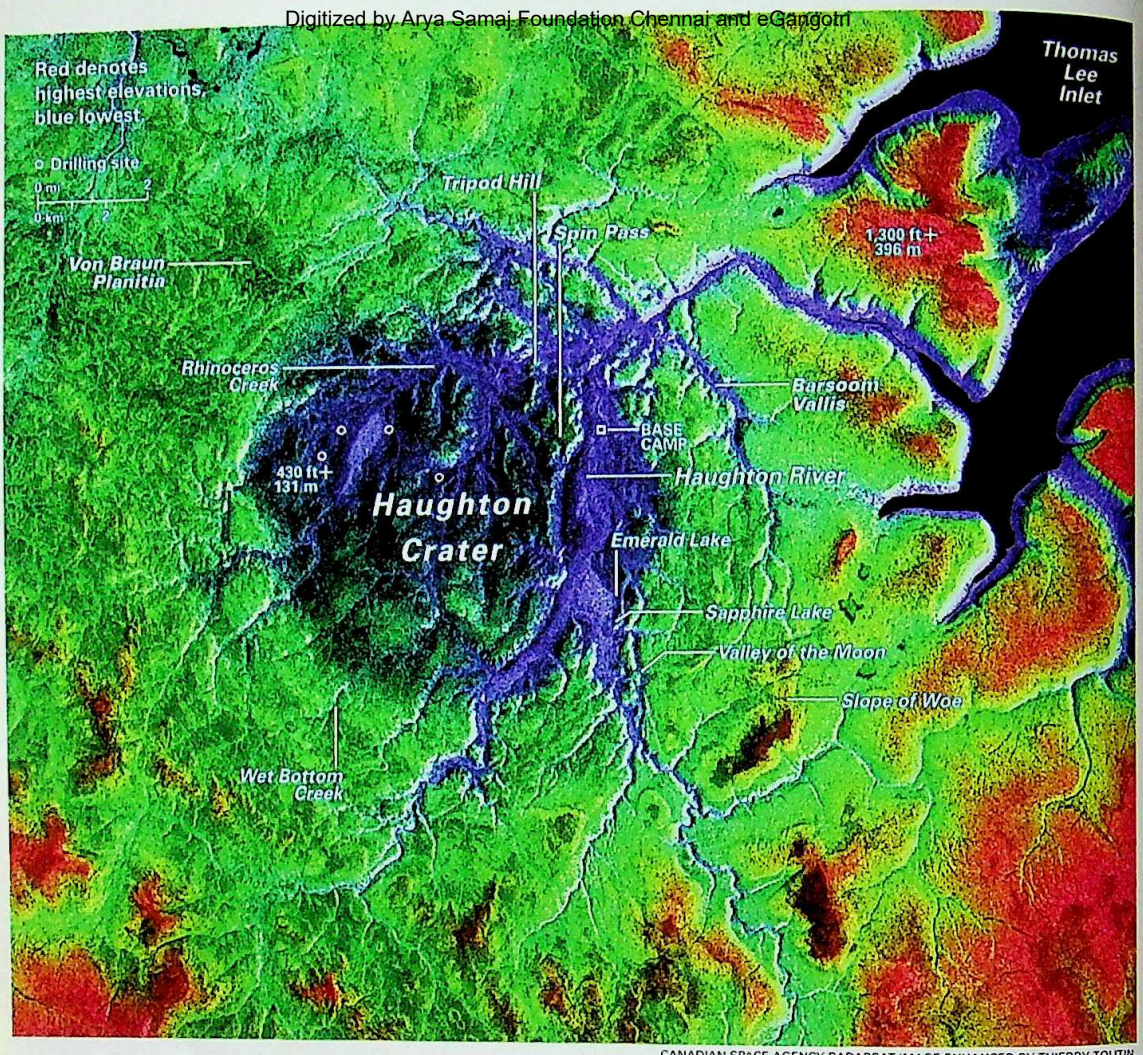

CANADIAN SPACE AGENCY RADARSAT IMAGE ENHANCED BY THIERRY TOUTIN, CANADA CENTRE FOR REMOTE SENSING, OTTAWA

Brian Glass, a graduate of MIT, Stanford, and Georgia Tech, shows me a laptop equipped with a camera, prototype for a device that would allow field astronauts to send data and images to each other and back to their base. Low-key but passionate, Glass wants to replace the "flags and footprints of the Apollo program" with hard-core science on Mars. "Apollo was never set up with long-term science objectives. That's what we should do on Mars."

And science is what we're going to do here, with each day's news posted on the expedition's website. Next morning is sunny and cool as I join Lee and Liam Pedersen, a South African roboticist, for an ascent of the grayish breccia hills behind camp. On a steep slope my ATV stalls. Starting it up, I give the machine too much gas, and it stutters and veers sharply to the left. In desperation I leap off to the right. "Now that was spectacular," declares Lee. He proposes naming the spot Spin Pass.

Atop the hill Pedersen takes light measurements of the breccia with his spectrometer, as he will later do with other rocks and lake-bed sediments. He explains that once these spectral signatures for different rocks or sediments are known, the same rock types can be identified from satellite imagery. It's a way of exploring without going anywhere.

Proceeding west, we stop here and there to search for small pointed rocks called shatter cones. "There are only two kinds of places on Earth you find them," says Lee, "nuclear explosion sites and impact craters." Shatter cones, a product of the catastrophic shock wave that accompanies an impact explosion, exhibit fracture lines that converge toward that part of the rock exposed to the blast.

We arrive at a small, nondescript butte rising like an altar from the surrounding turf. Lee characterizes it as a remnant of a deposit of lake sediment. "This is precisely what we

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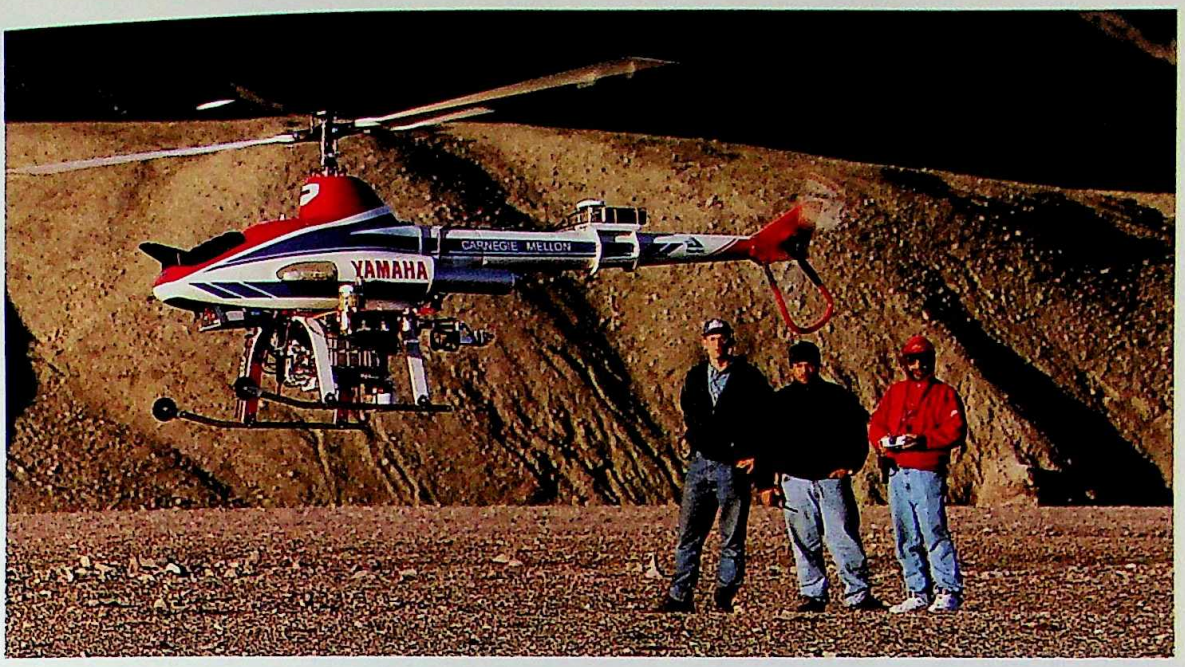
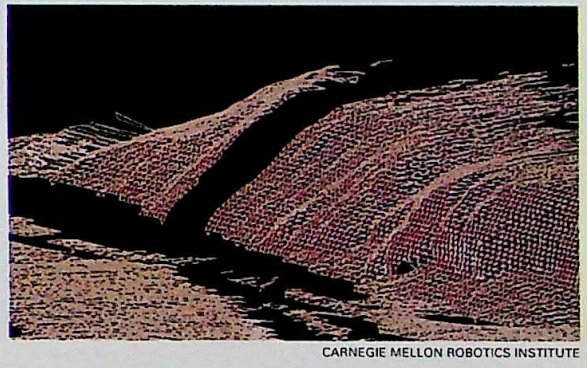


Robot rotors shatter the silence as scientists from Carnegie Mellon University test a small unmanned chopper designed to create three-dimensional maps using lasers and satellite data. The system has kinks. Hills in the crater can block transmissions from satellites, which are low on the horizon at this latitude. This may have caused the blank vertical stripe on a map (right) of a ridge by the Haughton River. A perfected system may one day map Mars.



CARNEGIE MELLON ROBOTICS INSTITUTE

would look for in a Martian crater to search for evidence of ancient bodies of standing water," he says. "It would be a major finding on Mars, the holy grail, hard evidence for water."

As water is the incubator of life on Earth, its presence would argue powerfully that there could have been life on Mars. Though most scientists believe that water is locked in the form of ice at the Martian poles, its discovery at the midlatitudes, where humans would most likely explore, would be of critical importance. Water would sustain astronauts and irrigate crops in greenhouses. Broken down into its components, water would yield oxygen for breathing and hydrogen that could be manufactured into fuel for rover vehicles and for rockets to return to Earth.

That evening we dine simply on pork and beans heated on a propane burner. Occasionally the chef-for-the-day attempts cuisine, which the group appreciates but ranks behind other priorities, like ruminating about rocks and dreaming of Mars.

A SENSE OF MISSION pervades Lee's crack multinational team, eager for fieldwork in this isolated place. Trips around the crater are called traverses, as were lunar excursions by the Apollo teams. In addition to Spin Pass, other terrain features are informally christened—the Valley of the Moon, Sapphire Lake, and the Slope of Woe, for a particularly challenging hill. On one traverse, after we have forded an unnamed stream many times, Lee invites me to give it one. I call it Wet Bottom Creek.

Career goals are no secret—going to Mars. Lt. Col. George Martin, a U.S. Air Force flight surgeon, has twice been an astronaut finalist. Jim Rice once shook the hand of Neil Armstrong at a reception, then hustled to the end of the line so he could shake the moon astronaut's

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Haughton's wasteland is a wonder for those attuned to the beauty of rock. With a spectrometer, fiber-optic cable, and laptop Liam Pedersen (below, at left) and David Reyes measure light reflected off rocks to determine their composition. Such data will help map the geology of Haughton and could help develop "robotic geologists" that may one day identify rocks on Mars. Will the robots find life? Perhaps. At Haughton piles of gypsum that arise from breccia (right) often house microbial algae in cracks sheltered from biting wind and cold.

hand again. "I've got my toothbrush packed; I'm ready to go in a heartbeat," says Rice, who wears orange-colored ski goggles when he's cruising on an ATV so the terrain will appear more Marslike.

These high achievers are as comfortable in the field as they are in the laboratory. Geologist John Schutt is also a mountain guide with years of experience in the Arctic and Antarctic; he has climbed 27,800-foot Mount Makalu in the Himalaya and traversed the Patagonian ice cap on skis. Charles Cockell, a British biologist, flew an ultralight over the Indonesian rain forest collecting moths, organized an expedition to Mongolia seeking long-eared hedgehogs, and, as leader of the "Forward to Mars" party, gained 91 votes in his challenge to John Major for the prime ministership in 1990. Nathalie Cabrol, a French planetary geologist, realized one day that she knew more about Martian geography than that of Earth. With barely a trace of a smile, she says, "I come from Mars."

I learn that this effort began with Lee, not with NASA administrators. Fascinated with the idea of finding a crater on Earth that could serve as a Mars analogue, he was drawn to Haughton. "It was in a polar desert," Lee says, "a cold, dry, windy impact crater, a common feature on Mars." Supported by NASA and the National Research Council, Lee and three other scientists went to Haughton in the summer of 1997 for initial fieldwork, which convinced him of the value of studying the crater.

Unfolding a map of Mars, Lee points to Northport Crater. "Coincidentally, it's roughly the same size and configuration as Haughton," he says. Lee points out the venous shapes of small valley networks near Northport and tells me that similar valleys lie just outside of Haughton's rim. "They seem to spring up from nowhere," he explains, "and they don't get wider and deeper downstream as do other

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valley systems on Earth." Lee hypothesizes that the valleys on both planets could have been created by melting masses of ice.

In the evening a slanting wind turns cold and stiffens, delivering ice crystals that scrape my tent like grains of flung sand. I crawl into a sleeping bag wearing socks, fleece, gloves, and hat, wondering whether the water inside my solar shower will ever bask in the warming rays of the sun. Snow begins to fall.

By morning the weather continues mostly nasty—temperature 29°F and a persistent 25-knot wind under a cloud-wrapped sky. Lee's lieutenants do not seem to mind. In cocoons of warm clothes they put on ski masks and mount ATVs for the three-mile ride to the lake bed to drill through ground ice for ancient sediments and breccia.

Threading sections of drill pipe while the wind spits snow in their faces, John Schutt and George Dunfield, another geologist, look like mud-spangled troglodytes. Schutt wears no gloves. His once bright rain gear is dulled by grime. Dunfield wears a half-buttoned black parka and a formerly white cap with ear and neck flaps. A perfectly hexagonal crystal fixes on Dunfield's parka momentarily and is gone.

To simulate Martian conditions, the drill has no liquid lubricants, which would contaminate the samples—and would probably freeze on Mars. A gasoline engine fires with a strident *wap-wap*, and the drill augers into the tundra, extracting cores. A similar procedure could be used to sample lake beds on Mars.

On a nearby slope Nathalie Cabrol digs out fossils of tree limbs, reminders that many millions of years ago the climate here was temperate, supporting such creatures as a primitive rhinoceros. Today the lake-bed tundra remains an oasis of life, albeit a thin one, at the 75th parallel, some 400 miles from the north magnetic pole. We see only a nesting pair of

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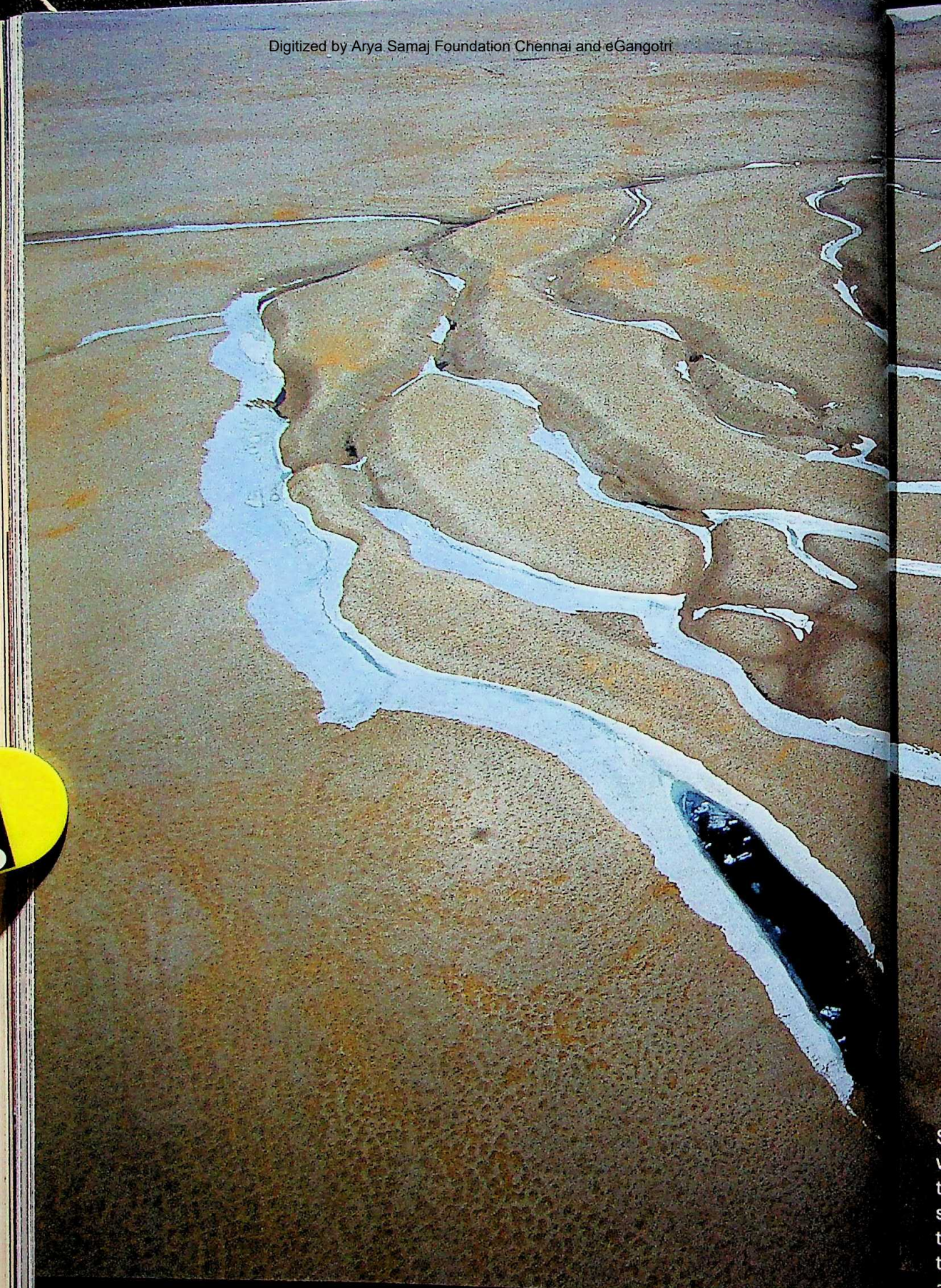

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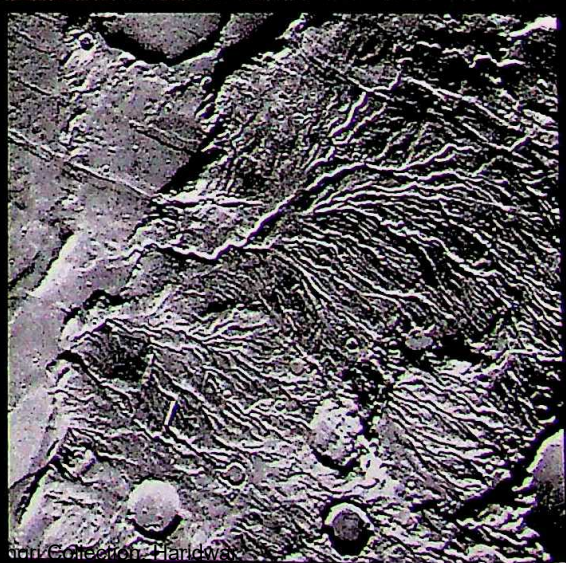
Silvery hieroglyphs, narrow valleys filled with thawed ground ice and snow tell a tale of Devon Island's glacial past. Called small valley networks, these fingers seem to spring out of nowhere, suggesting that they were channels for meltwater formed at the edge of a shrinking ice cover. Similar shapes on Mars (right), though on a vastly larger scale, may have formed the same way—a clue to the planet's climatic past.



NATIONAL SPACE SCIENCE DATA CENTER, NASA, GREENBELT, MARYLAND

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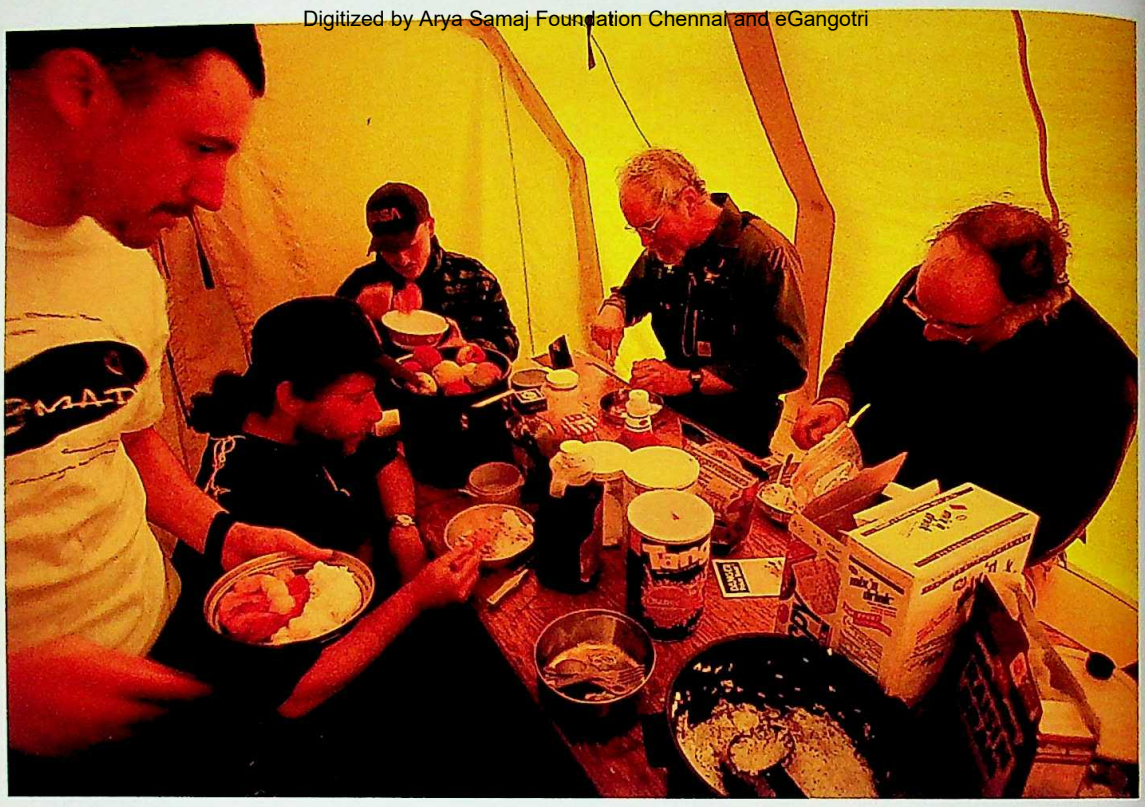

Haughton's mess tent offers barely enough room to share both food and ideas. "The exchange of information during meals was invaluable," says roboticist Alex Foessel, at left. The chow wasn't bad either. "There's no reason you can't have good coffee in the field."

Canada geese. Two adult musk oxen with a calf. A solitary jaeger circles overhead, prowling for lemmings. There are occasional caribou, such as the two grazing placidly a few hundred yards away, unaffected by the clatter of the drill. Slowly they move up a gully.

I wander over a small mound called a pingo, a hump created by subsurface ice pushing upward. On the tundra I see the deep indentations of musk ox hoofs, bunches of electric green arctic poppies, and arctic willows that creep along the turf like infantrymen under barbed wire, as if their deciduous limbs are reluctant to rise and confront the wind.

I sit on a rock fragment overlooking a river valley, scanning for tens of miles, seeing no walking or flying creature until I become aware of something maneuvering on the underside of my hat brim. I remove the hat and a mosquito wanders onto my gloved left hand, slipping because the smooth leather affords it no purchase. I remove the glove and offer the insect flesh, surely a fine meal in this sparse place. But it declines, falls to the ground, and listlessly crawls away, dulled by the cold.

Beyond the greenish floor of the lake bed I see the pale humps of breccia hills and—suddenly—along the river toward the west three black specks, the musk oxen with calf. I lean back to enjoy the scene, and my right hand encounters caribou droppings, fresh.

The ATVs fire up, coughing like a squadron of propeller-driven airplanes. I hurry back to join a small convoy heading west, led by Schutt. We transit a valley. Across the way is a large white conspicuous object, conspicuous because white is seldom seen here in the summer. I scan the object with binoculars. It's a polar bear, someone declares. I say, it's not a bear; it's not moving.

Schutt slings his shotgun and motors down a ravine to emerge about a hundred yards from the object. Suddenly it moves. I think, good grief, it's big enough to be a bear; it is a bear. The animal stands on all fours, stretches fore and aft in very unbearlike fashion, and runs off. No, bears don't stretch like that. Must be a caribou. A white caribou? Schutt returns to

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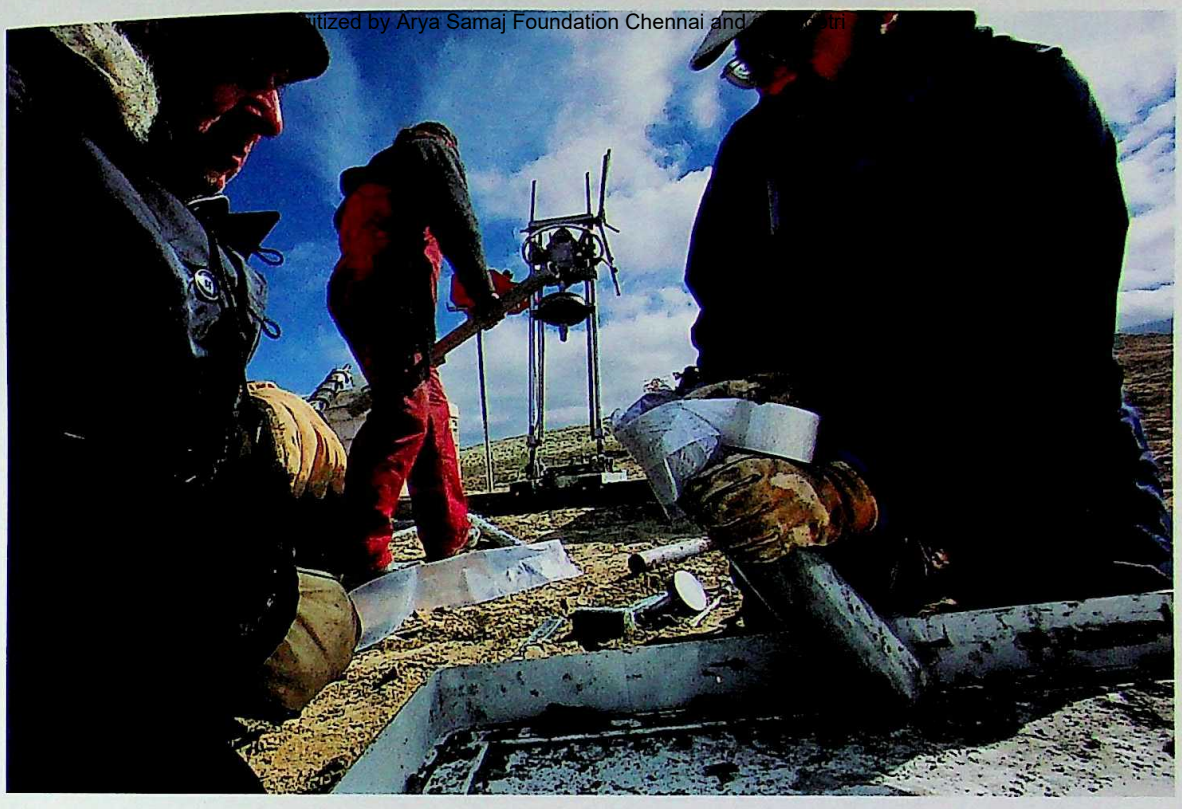

Grasping history, George Dunfield wraps a sample of Haughton's lake-bed sediments—the only remnants of the Miocene known to exist in the Arctic. Refinements of drilling techniques used here may help retrieve Martian sediments, perhaps rich in fossil remains.

report that it's an arctic hare—a rabbit! I'm feeling foolish. How can this be?

Brian Glass explains that the monotonous, treeless terrain offers few cues for perspective, and things can appear larger than they are. Indeed, Arctic explorer Vilhjalmur Stefansson wrote in 1913 about stalking a grizzly only to discover, finally, that his grizzly was a marmot.

Fresh tracks along the watercourses reveal the presence of polar bears. In the sand Jim Rice measures a footprint eight inches wide. In a valley east of camp two sets of tracks ascend a steep slope straight up with never a waver. I marvel at the power of the beasts who made them. Because my tent is closest to the Haughton River, I keep a shotgun in the tent vestibule at night, consoling myself that we have found no tracks by the Haughton. Much later it occurs to me that bear tracks may not have imprinted on its rock and gravel banks.

On July 13 drill cores are stowed, rocks are sorted, tents struck, and a group of scientists departs, making room for newcomers. This shift brings a biologist, a computer scientist, an expert in artificial intelligence, and a team of robotics experts from Carnegie Mellon University with a remotely controlled helicopter for mapping Haughton's terrain. But first a pestering wind blows from the northeast and gathers strength, popping pegs on Lee's tent, which makes a good imitation of a parachute until we smother it. During dinner the sides of the mess tent thump and crack. Schutt estimates the gusts "at around 60 knots."

There is nothing to do but seek shelter and hope for the best. My tent, designed to withstand such blasts, rocks but holds fast. When two smaller tents flatten, people secure them to ATVs with bungee cords. The paraphernalia tent, whose side begins to flutter, spews loose items to the wind and requires three anchoring ATVs. Bruno, who routinely sleeps out in blows and snows, begs for entry into a tent. Schutt fashions a windbreak from a gear case; dog and humans hunker down for the night.

By morning the camp is windless, sunny, and warming. Perfect weather to fly the

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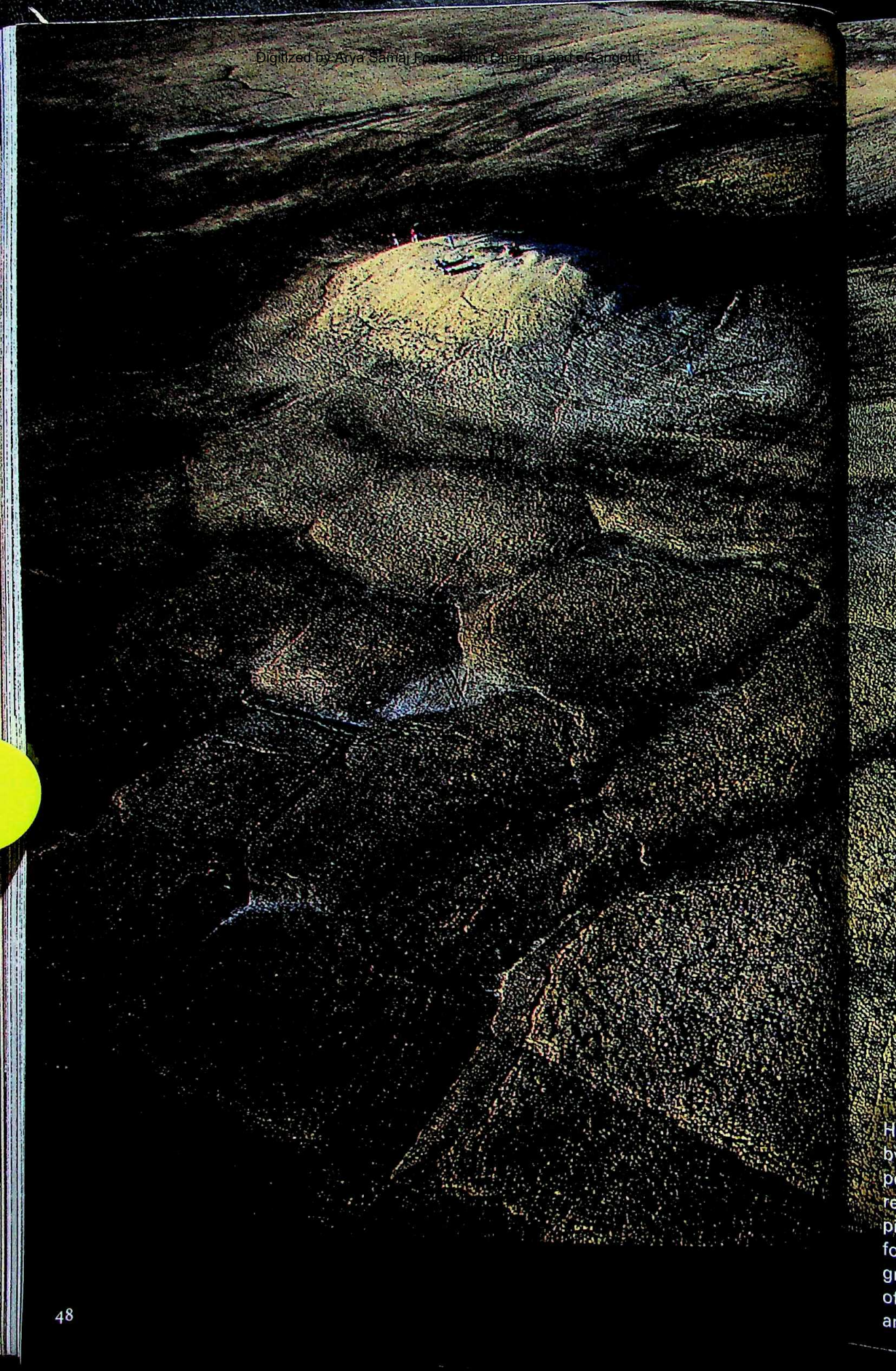

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Haughton's face is freed from monotony by the grace of geometric curves. Huge polygons form as frozen ground thaws and refreezes in annual cycles. Mounds called pingos, one a hundred feet across, at left, form as soil heaves upward over underground ice. Similar features on Mars (right) offer the hope that water may be present and accessible to future human visitors.

NATIONAL SPACE SCIENCE DATA CENTER

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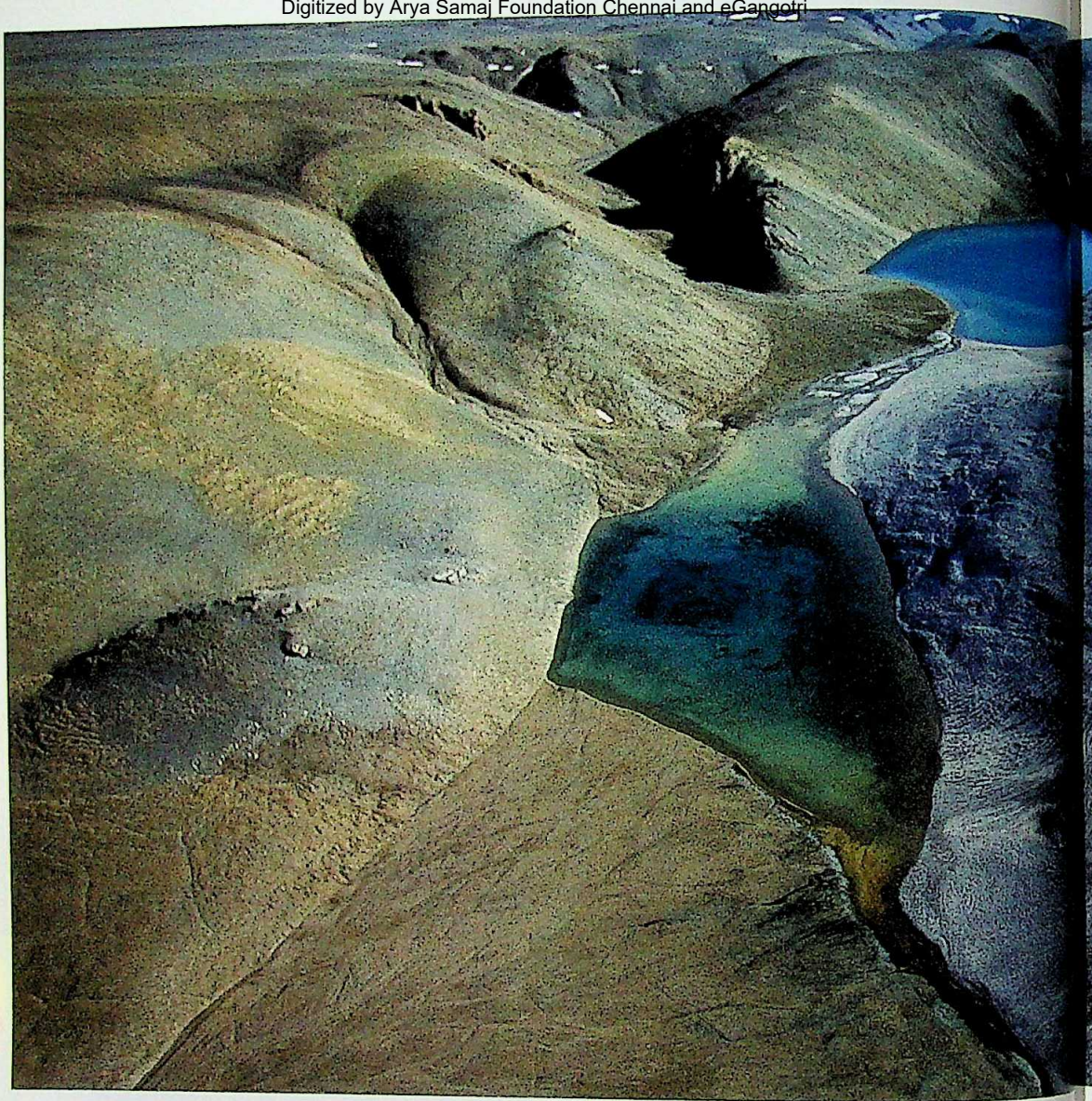

14-foot-long, 160-pound helicopter used in Japan for crop-dusting. Team director Omead Amidi of the Robotics Institute at Carnegie Mellon has added 320,000 dollars' worth of sensing, positioning, laser mapping, and navigational gear. Ryan Miller monitors the mapping system. Pilot Mark DeLouis gives the machine commands from a handheld console, and for the next few days the helicopter goes about its mapping tasks while the dentist-drill whine of its engine disturbs the peace of the camp seagull. DeLouis keeps his eyes fixed on the machine as Amidi walks beside him, pointing out rocks so the pilot will not stumble.

Charles Cockell, the British biologist, heads to the tundra, seeking lemmings for a genetics study. He sets out long, baited aluminum traps, but the lemmings will have none of it. After several days the final score is Lemmings 20, Cockell 0. The biologist gives up, grumbling—"The rascals. Next time I'll bring dynamite."

His work has been recorded by a camera-equipped laptop manipulated by Rick Alena, a computer scientist. Alena drapes a black cape over himself and the machine as a shield from the sun and looks like a photographer from the Civil War. All this is rudimentary and prelude, he says. "Someday an astronaut will carry sensing and communications gear on the wrist."

Cockell is impressed that the drilling team has acquired two intact cores from the crumbly breccia. "The intense heat of the impact would have created boiling hot water," he speculates. "Perhaps heat-adapted microorganisms like

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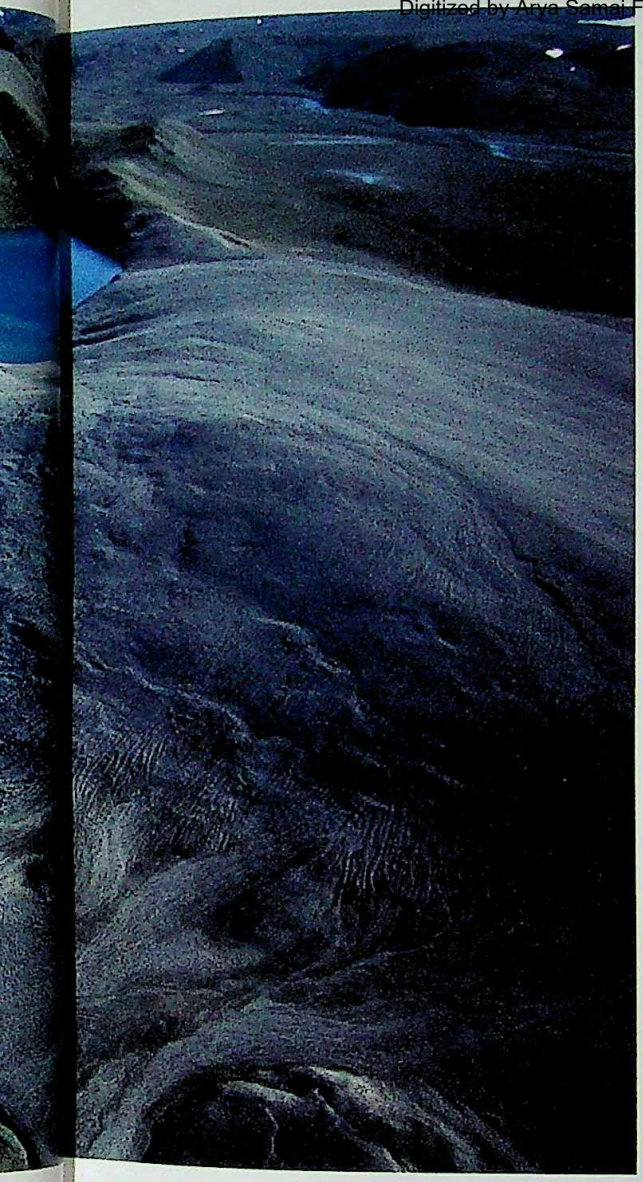

Set like gems in an austere brooch, Sapphire and Emerald Lakes lap the line between gray impact breccia and Haughton's rim. The lakes' different hues may be due to minerals, plants, or depth—among the many unknowns scientists will probe in their quest to understand Haughton and, by extension, Mars.

you see in Yellowstone Park's hot springs might have gained a foothold in this environment. If we find the fossil remains of such microorganisms here, it will help us in our search for them in craters and river valleys on Mars." A team of scientists at NASA Ames will search for these biological signatures in the cores.

Late on that final evening I make a trip with Lee to Tripod Hill, so called because at a certain spot a camera-on-tripod is erected to record any changes in a mudslide hundreds of feet long across the valley. Lee has explained that this is an important mudslide that might tell us something about Mars, where similar looking slides have been spotted. Over three weeks the dark mudslide at Haughton has lightened considerably, indicating that water from melting ground ice has dried up. Lee wonders whether the Martian slides also change in color, perhaps revealing the presence of ground ice—water! A provocative possibility indeed, and another element in the equation that could bind Haughton to its sister craters on Mars.

For the moment I've had enough science. I walk to the crest of Tripod Hill, where hordes of fractured rocks lie golden in the midnight sun. I pick up a tablet-size shard that bears several egg-shaped fossils, which a paleontologist later identifies as small creatures from an Ordovician sea nearly half a billion years ago. Somehow this particular area of the crater escaped the ravages of the impact explosion. I know that it is likely that no other human being, except for a few of the expedition members, has ever stood at this spot.

There is no wind. Sharply outlined in the crystal air, the crater's features present for inspection: great loaves of breccia creased with sinuous valleys, Rhinoceros Creek glistening through the lake-bed sediments, eminences of dolomite protruding like fists through the breccia, the Haughton River canyon proceeding to the sea. It is a scene like nowhere else on Earth. Could it once have been this way on Mars?

Close enough, says Robert Zubrin, president of the Mars Society, a group whose members range from aerospace engineers to poets, all devoted to the exploration of Mars. By summer of the year 2000, Zubrin tells me, his group will build a 1.2-million-dollar, three-tier simulated Martian habitat on Devon. In the shape of three tuna cans sitting on one another, the structure will house six astronauts and scientists with food and equipment sufficient for two months of simulated Martian traverses. Zubrin adds that his organization plans to lobby the new American President in 2001 to commit to a Mars mission, as President John F. Kennedy committed to the moon in 1961.

Looks like Pascal Lee and his band are onto something. □

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By MICHAEL E. LONG
Photographs by TIM LAMAN

Bolts of blazing color reveal a red-knobbed hornbill perched deep in rain forest canopy on the Indonesian island of Sulawesi. Many of the world's 54 hornbill species are at risk as humans destroy the birds' habitat and hunt them for their bills and feathers or simply for food.

THE SHRINKING WORLD OF HORN

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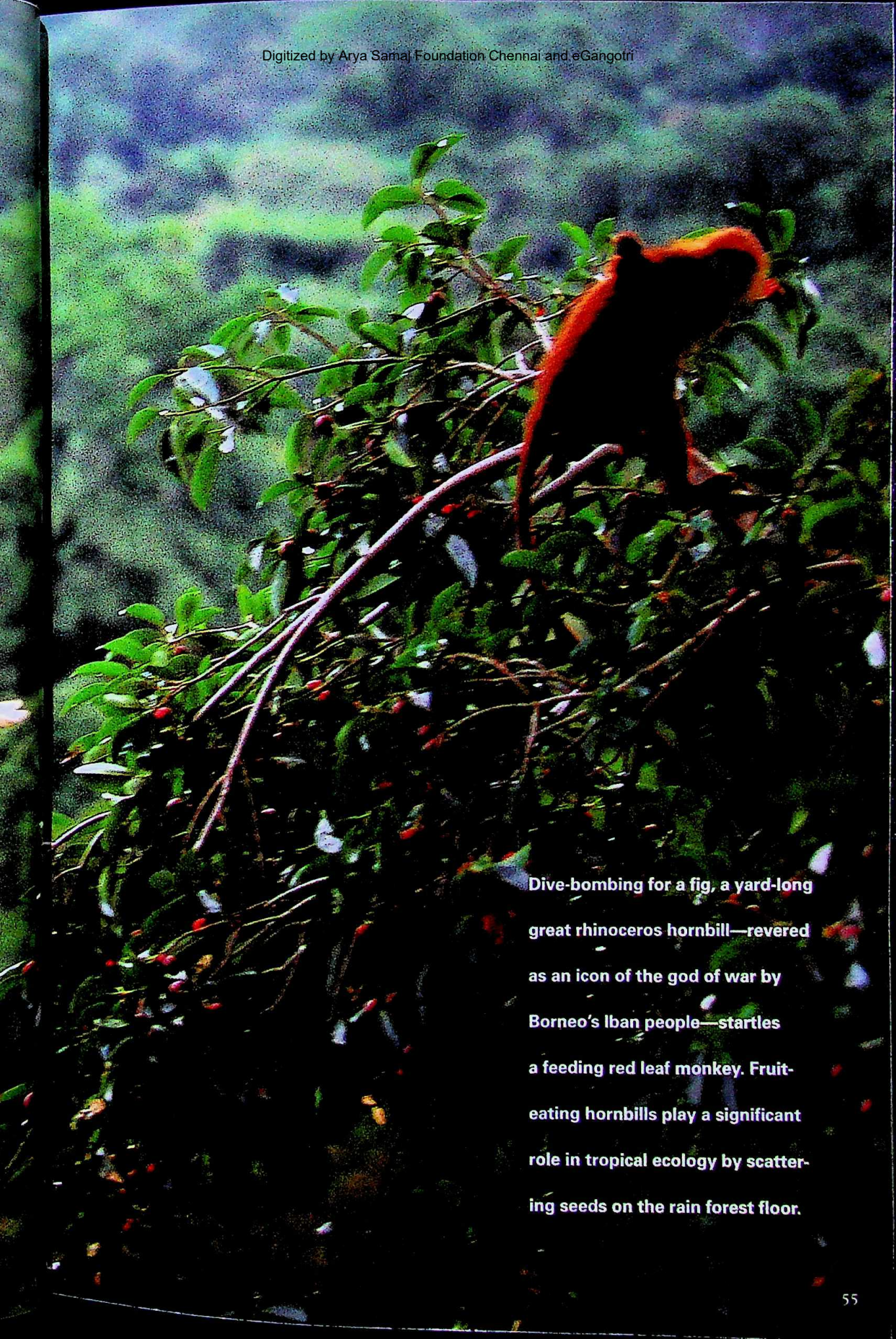

Dive-bombing for a fig, a yard-long great rhinoceros hornbill—revered as an icon of the god of war by Borneo's Iban people—startles a feeding red leaf monkey. Fruit-eating hornbills play a significant role in tropical ecology by scattering seeds on the rain forest floor.

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NOT MANY PEOPLE would recognize the slit high in the trunk of the knobthorn tree as the entrance to a bird's nest. And nobody, unless he had a high-power telescope trained on the half-inch-wide opening, would see the gray-rimmed pupil peering through it. The youngster inside, an African red-billed hornbill, is hard at the keyhole of its new world, considering whether to fledge—which may not seem to be a particularly good idea in the penetrating drizzle of this dank morning in South Africa's Kruger National Park.

Mother and father hornbill are nowhere to be seen, and that is by design—it is up to the youngster to peck its way to freedom. For this, nature has provided the bird with a powerful bill. The bill is an integral part of its skull, which is fastened to upper vertebrae that are fused and therefore stiff, creating, in effect, a feathered pickax.

After observing its surroundings for many minutes, the bird begins to peck, and a hole is made. A head protrudes. The hornbill now has two eyes on the world, and it pauses for additional observation. More pecking, then head and right wing are free. Then—pop!—the magpie-size hornbill is out of the nest and flying to a branch, where it sits, once again taking the measure of its surroundings.

But how did the bird get in the nest in the first place? The answer is one of the great tales of animal behavior, for most hornbill females make unique nests in tree cavities, using their bills to wall themselves in with a plaster made of mud, droppings, chewed wood and bark, and other detritus. They leave only a slit, narrow enough to deter predators but sufficiently wide for the male to present food from the outside. After a few months, having laid and incubated their eggs, the females peck a hole in the wall and leave. The chicks wall themselves back in, to fledge at their leisure.

The hornbill universe, with initial entries appearing in the fossil record some 15 million years ago, comprises 54 species of birds. Their range includes most of sub-Saharan Africa and extends east to the forests of Southeast Asia and the Solomon Islands.

Africa is home to the largest and the loudest —the nine-pound southern ground hornbill's deep bass call booms as far as two and a half miles, about the same distance a lion's roar carries. The African dwarf red-billed, smallest of hornbills, is the size of a dove.

Hornbills possess magnificent beaks—more than 13 inches long on one great pied hornbill —which they wield like forceps to grasp and toss insect prey in the air, then with impressive coordination catch it in their gullets. Bills are also used to poke among branches for fruit or even to keep a poisonous snake at bill's length to protect vulnerable body parts. Many hornbills wear on their beaks a horny, sometimes spectacular crownlike protrusion called a casque, hollow except for the nearly solid, ivorylike casque of the helmeted hornbill.

Whence, presumably, the name. Examining a tropical bird whose casque had two peaks, the taxonomist Linnaeus in 1758 bestowed the scientific name *Buceros*, Latin for "having ox's horns." This probably accounts for the common name; at least it will do until a better explanation comes along, says my companion Alan Kemp, an ornithologist and curator of birds at the Transvaal Museum in Pretoria.

Kemp suggests we prowl for more hornbills. By park regulations we are obliged to remain in our truck, lest one of Kruger's 2,000 lions decide to take advantage. We drive past elephants, giraffes, warthogs, white rhinos slightly smaller than tanks and are delayed for a time by a roadblock of lounging lions. Farther along Kemp picks up a squirrel killed on the road and puts it on the backseat.

Later in the afternoon a group of southern ground hornbills crosses the road and heads into the bush. The dark-bodied birds walk deliberately through the long grass with their heads canted downward, in the manner of cowled monks proceeding to choir. There are seven, about the size of turkeys, wearing red skin folds around their heads and throats and

Room service: A red-knobbed hornbill arrives with breakfast, which he will regurgitate for his roughly three-month-old chick safely inside a nest hole in an *Alstonia* tree. Though its mother has left the confines of the nest, the chick remains within for another few weeks, dependent on its parents until it fledges.

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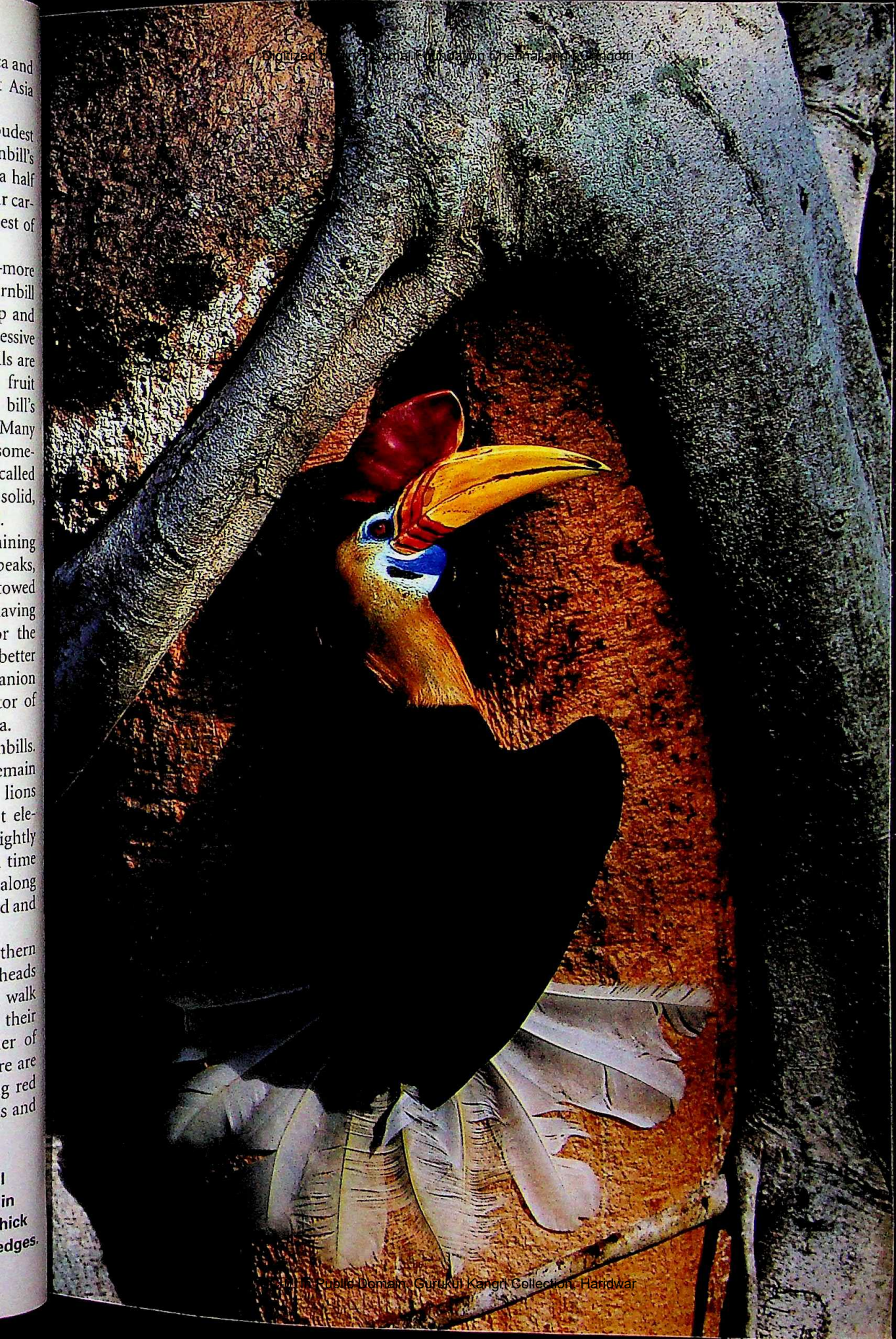

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maneuvering long black bills to knock back insects. The birds keep their bills open a bit to ventilate the afternoon heat.

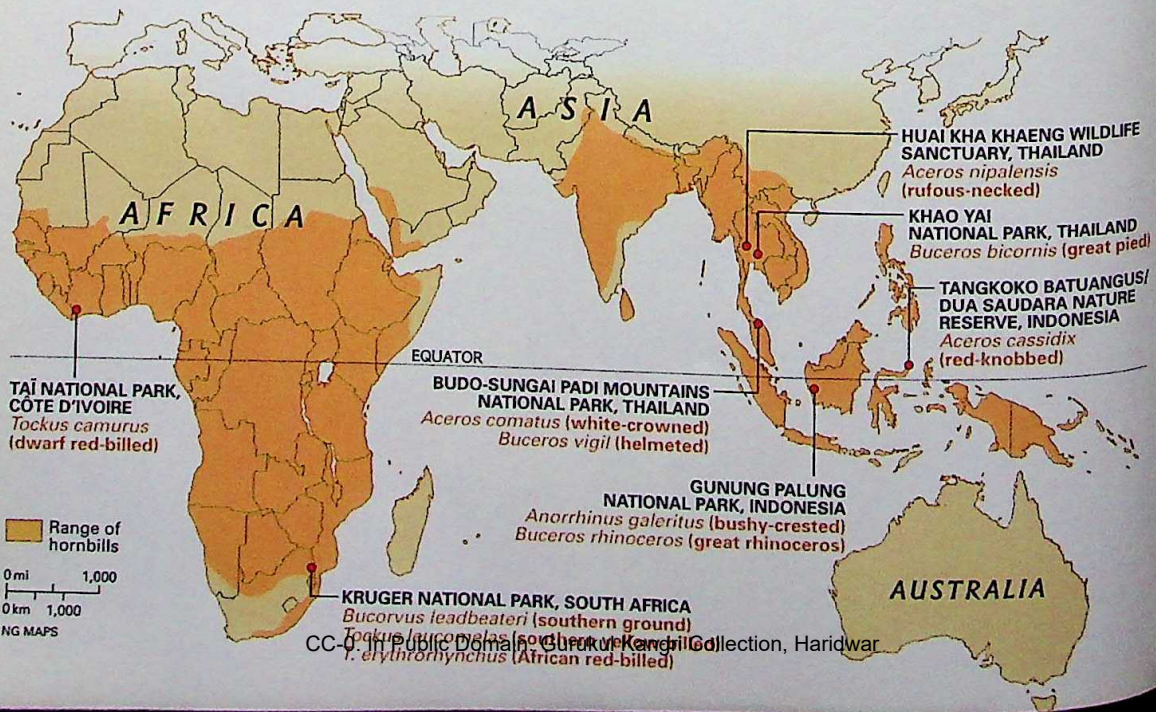
Kemp puts the truck in four-wheel drive, and we follow. He counts two mature males, a female, and four immature birds. Kemp tells me that ground hornbills, once plentiful in the savannas, have disappeared from 70 percent of their original range in South Africa. It is the old story of habitat destruction, birds falling prey to poison set out for nuisance animals, and a twist—persecution. The territorial and pugnacious hornbills wore out their welcome with farmers by a pernicious habit of attacking their own images reflected in windows. Bird shatters window. Farmer shoots bird.

"I know one farmer who had 27 windows smashed in one afternoon," recalls Kemp. The birds would add irritation to injury by "returning in two or three weeks to see if they had gotten rid of their antagonists."

Though ground hornbills can fly well enough, they prefer to walk while foraging. As if on a mission, the birds we're following traverse methodically in a skirmish line, feeding on insects and an occasional mouse. Our truck pitches and rolls over the rough terrain, splinters a log, and, when scraped by acacia thorns, responds with a screech like fingernails dragged across a blackboard. The birds spook but settle down. Content with our presence, they mount a marula tree's thick branch and extend their wings, exposing bare skin to dissipate more heat.

Refreshed, they march off and resume foraging. Kemp tosses the dead squirrel toward the troop, and the hornbills find it of interest. A male retrieves it and carries it around as if it is a trophy. When he drops it by accident, another male edges against him sideways and, as if recovering a fumbled football, grabs the squirrel and proceeds to march and shake.

Kemp explains that we are witnessing status-control behavior, in which one bird will withhold or bestow food to show



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dominance. It appears that this bird is in a withholding mood.

I am puzzled that the former possessor of the squirrel seems unconcerned. Kemp, who estimates that the life span of these birds averages around 45 years, observes, "The two males may have a 20-year-old relationship. Who knows what's gone on between them? It's more like watching primates than watching birds."

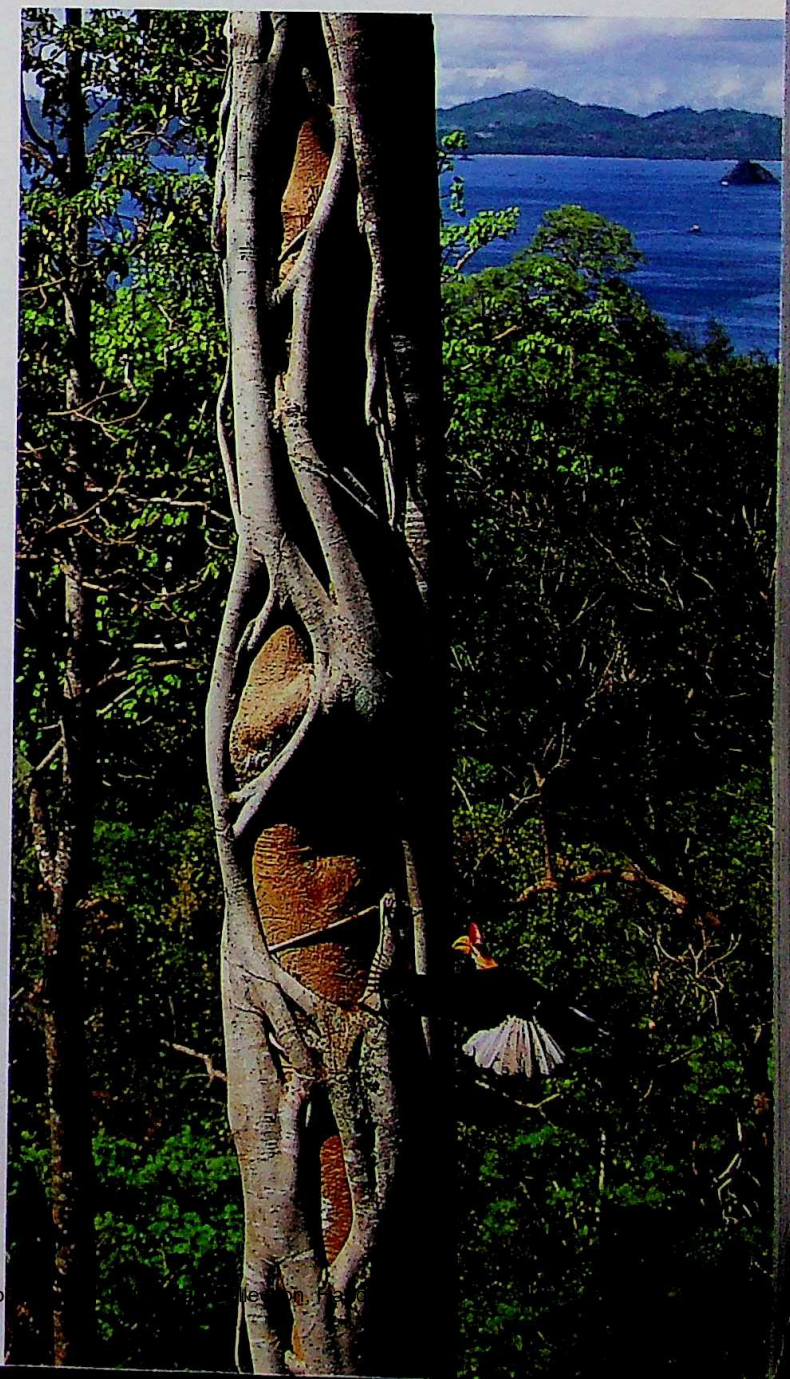
Suddenly two juveniles dart in to grab the squirrel and a foofaraw erupts. "The breakdown of law and order," Kemp notes. The older bird is too strong and pulls the squirrel away. The bandits calm down. The male turns and in a determined swallow knocks back the whole squirrel, head first.

I feel privileged to be in the presence of these hornbills, which exhibit qualities I never before associated with birds. They are dignified, self-assured, confident, inquisitive if not meddling, and have a tendency to manipulate.

I love to watch birds, hear them sing. But as things go in the animal kingdom, one-on-one most birds are afraid of me. I don't have that impression with ground hornbills—these birds are gents; they have chutzpah. Think about it: Have you ever had a turkey or a pheasant walk up and look you forthrightly in the eye?

ASIAN HORNBILLS, however, are not likely to look anyone in the eye. They're too busy hiding in the forest, guarding their privacy, so wary of human intrusion they contrive to bomb you if you don't mind your manners. So explains Pilai Poonswad, one of the most dedicated of hornbill researchers, recalling her first encounter with a great pied hornbill in a Thailand forest 20 years ago. "I made the mistake of gazing at a nest in the open, not from a blind," she remembers. "The male didn't like it. He dropped tree branches on me."

Some of the Asian species are among the most colorful of birds, drawing from a palette that includes russet, pink, yellow, subtle blue,



It's easy pickings for a bushy-crested hornbill as she plucks a ripe *Aglaia* fruit from a twig (facing page). Most species—like the red-knobbed hornbill at right—carry such food in their gullets when flying to the nest to feed their young. The casque, a horny protrusion on the upper bill that gives hornbills their name, may play a role in sexual selection or amplify the birds' calls. From loud barks to thunderous booms, hornbill cries resound across a range that extends from the dry savannas of sub-Saharan Africa to the lush forests of Melanesia.

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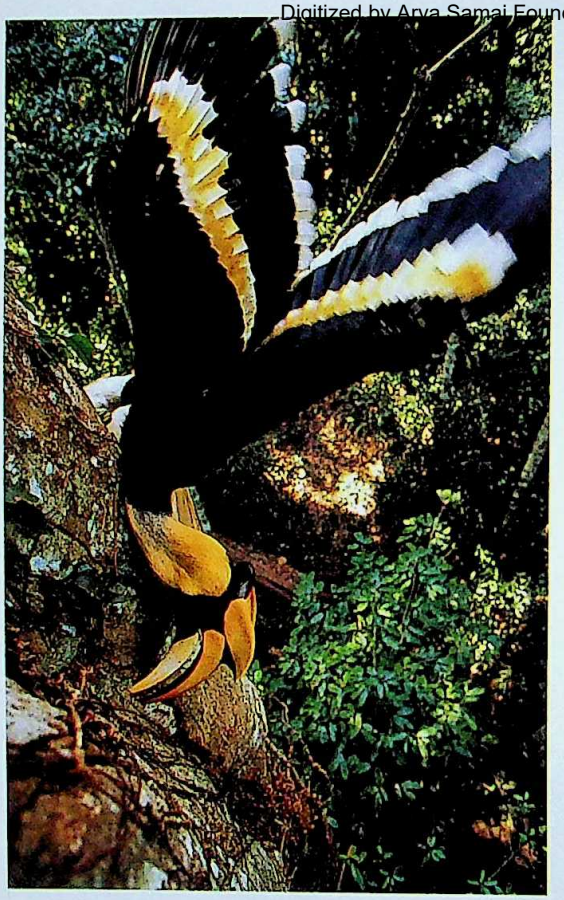


Sole provider for his confined mate and chick, a great pied hornbill in Thailand's Khao Yai National Park (left) delivers as many as 13 fruit and insect meals each day. The female has all but walled up the nest hole to guard against predators. Unfazed by the camera's careful intrusion (see Point of View in this issue), she passes a morsel to her four-week-old (right). "One day the male arrived with a green cat-eyed snake [below]," says photographer Tim Laman. "The chick swallowed it like a string of spaghetti." Hornbill pairs often return to the same tree every season.

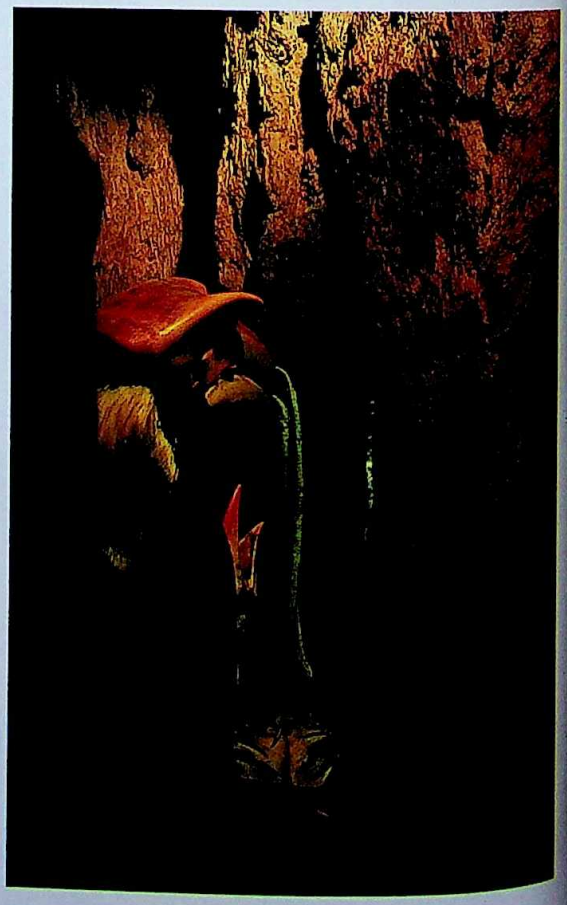
and vibrant red. The luminescent reddish orange neck feathers of a rufous-necked hornbill make it the handsomest hornbill of all, in Poonswad's opinion.

Known to all simply as Pilai, Poonswad is a parasitologist who turned to hornbill research as an avocation that grew into fierce devotion. "I fell in love with them," she says. "I will fight anybody to protect them." Then, with a demeanor the texture of iron, this diminutive woman adds, "I will fight to the death."

I have met Pilai at Khao Yai—"big mountain"—the first of Thailand's national parks, 800 square miles of rumpled terrain northeast of Bangkok. It is nothing unusual for an elephant to stroll through the parking lot of the visitors center, which is surrounded on all sides by the park's other wild creatures, including tigers, bears, cobras, and several of Thailand's 12 species of hornbills.

From the veranda of my bungalow at the edge of the forest, Pilai points out long-armed gibbons cavorting in the trees. A fidgeting rainbow of color called a jungle fowl trills *cock-a-daw-do,* betraying its role as an ancestor of the domestic chicken. It scratches busily for insects; I wish I could interest it in decimating the army of short-legged ants on my bed.

Pilai introduces me to Boonma Saengthong, a lean and serious man who once shot and killed two poachers when he worked as a park ranger. Boonma explains that he gave the poachers plenty of warning, *(Continued on page 66)*



Denver writer MIKE LONG's first NATIONAL GEOGRAPHIC article appeared in 1972; his most recent, on prairie dogs, in April 1998. Field biologist TIM LAMAN has photographed strangler figs (April 1997) and orangutans (August 1998) for the magazine.

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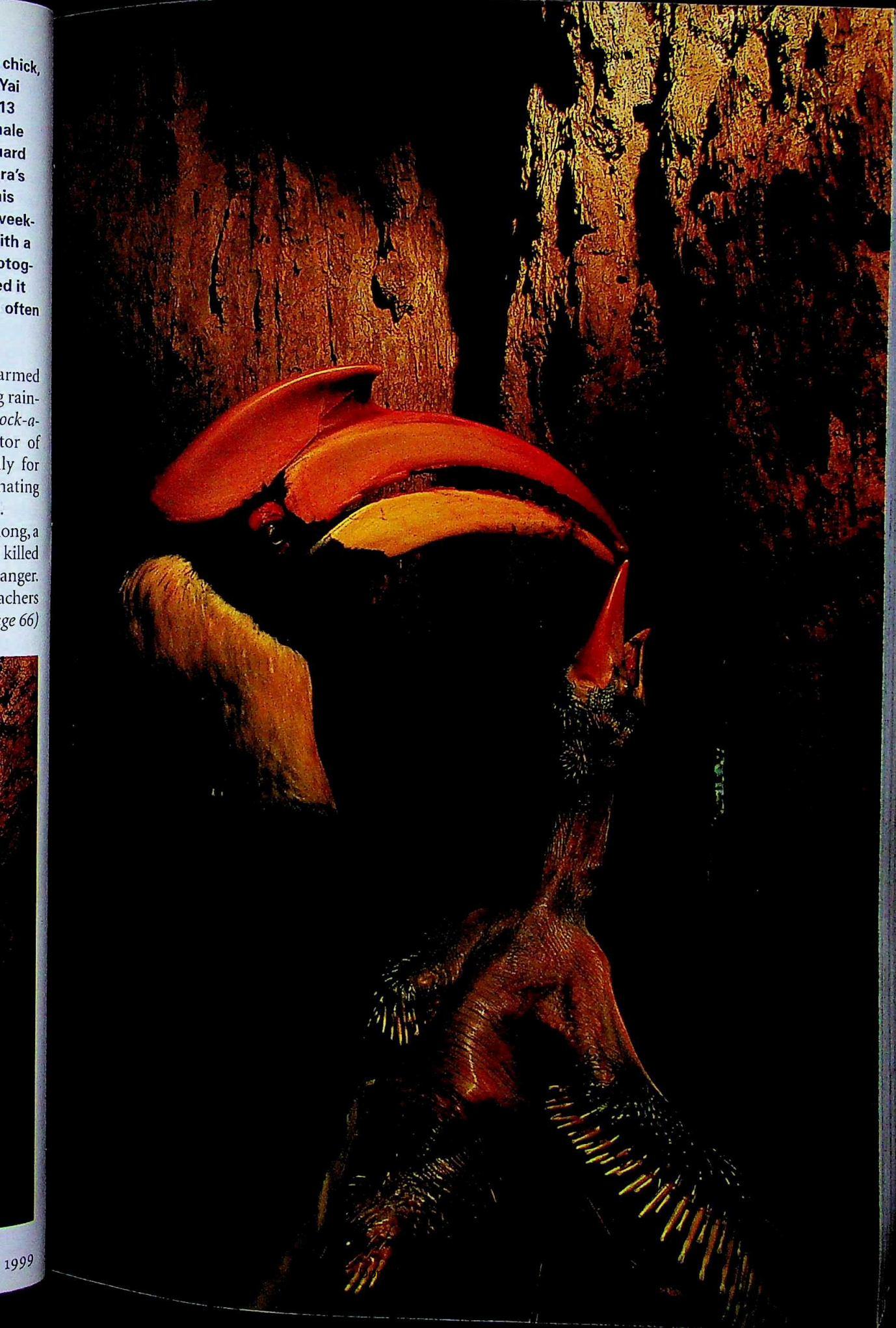

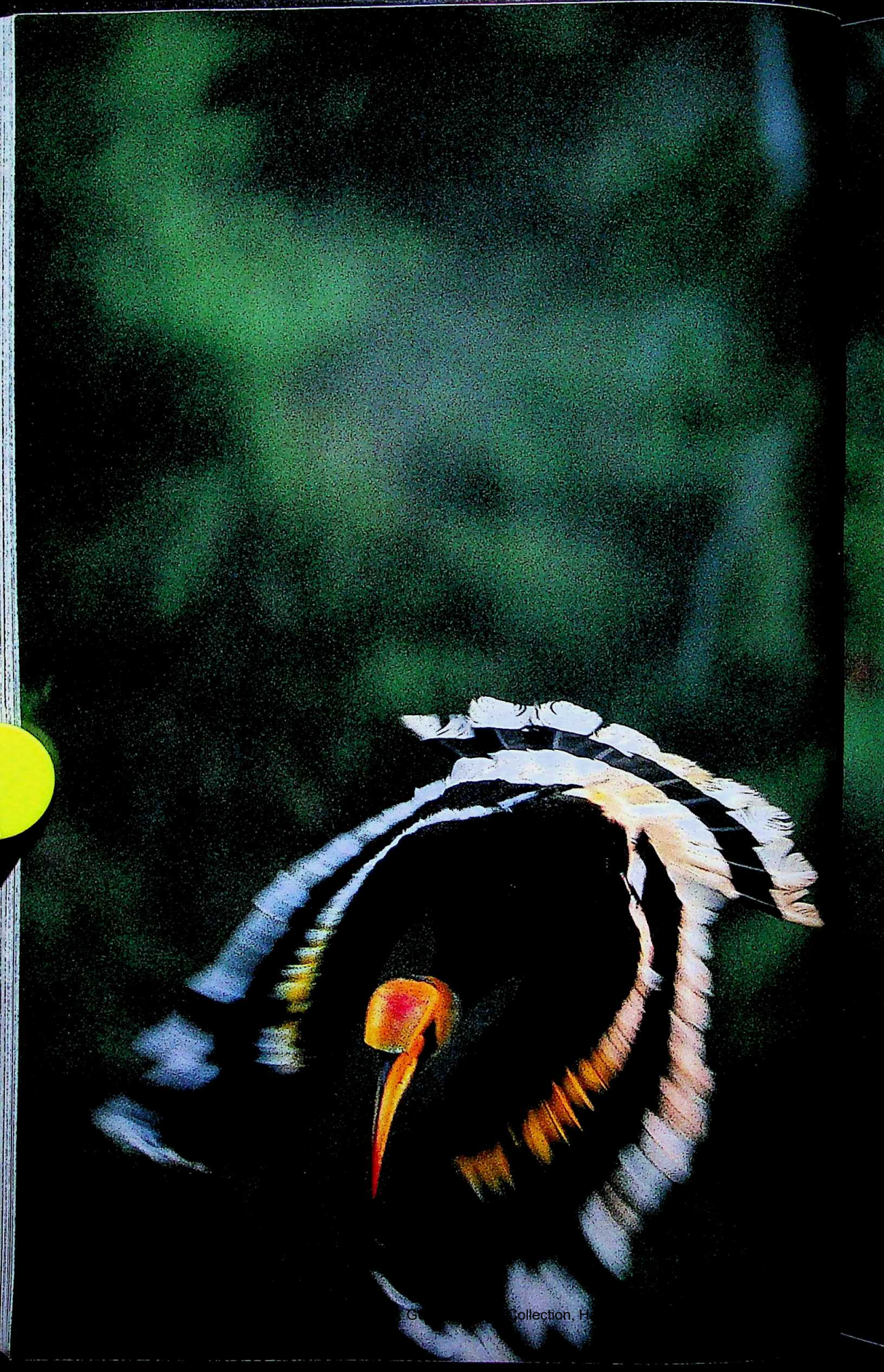

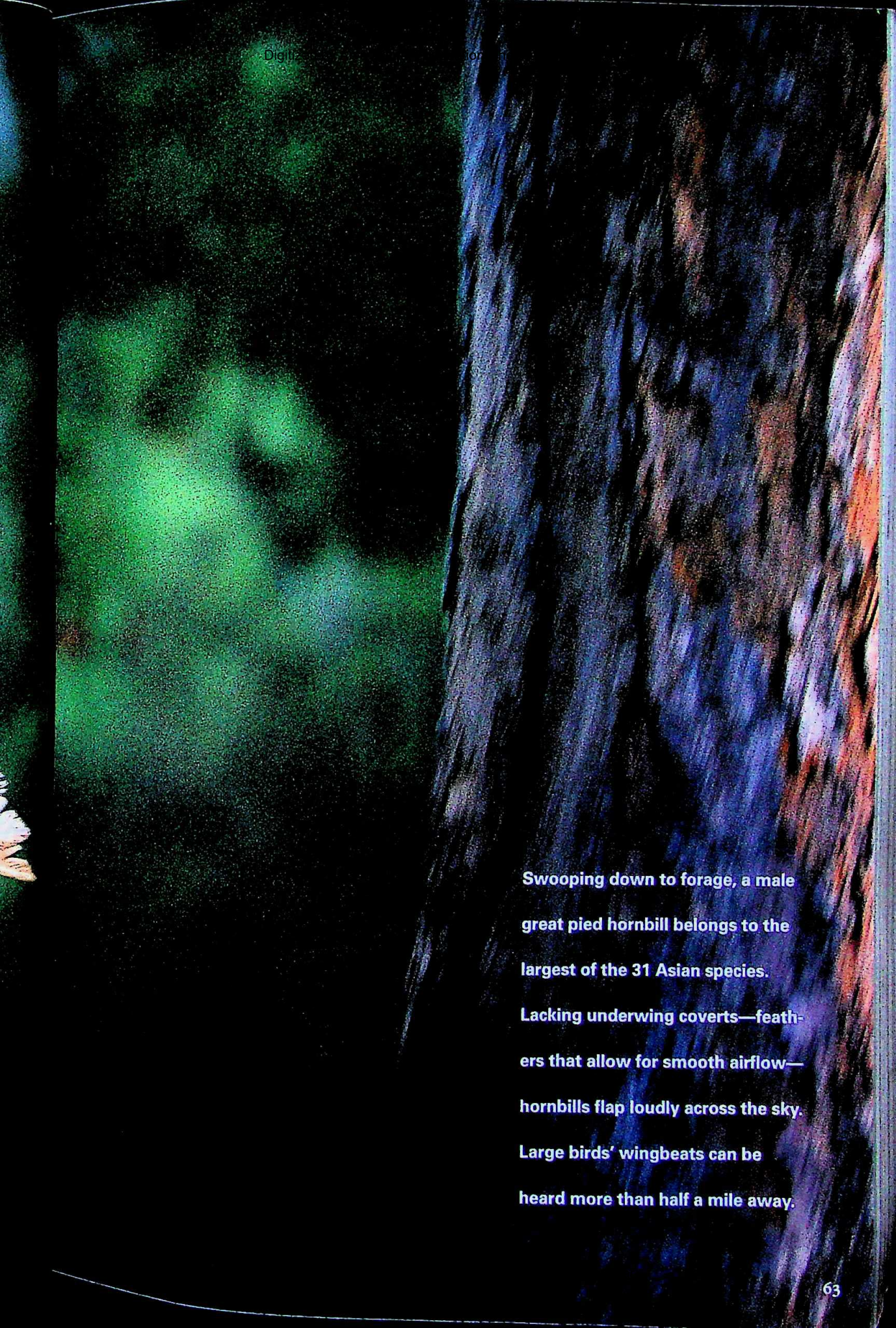

Swooping down to forage, a male great pied hornbill belongs to the largest of the 31 Asian species. Lacking underwing coverts—feathers that allow for smooth airflow—hornbills flap loudly across the sky. Large birds' wingbeats can be heard more than half a mile away.

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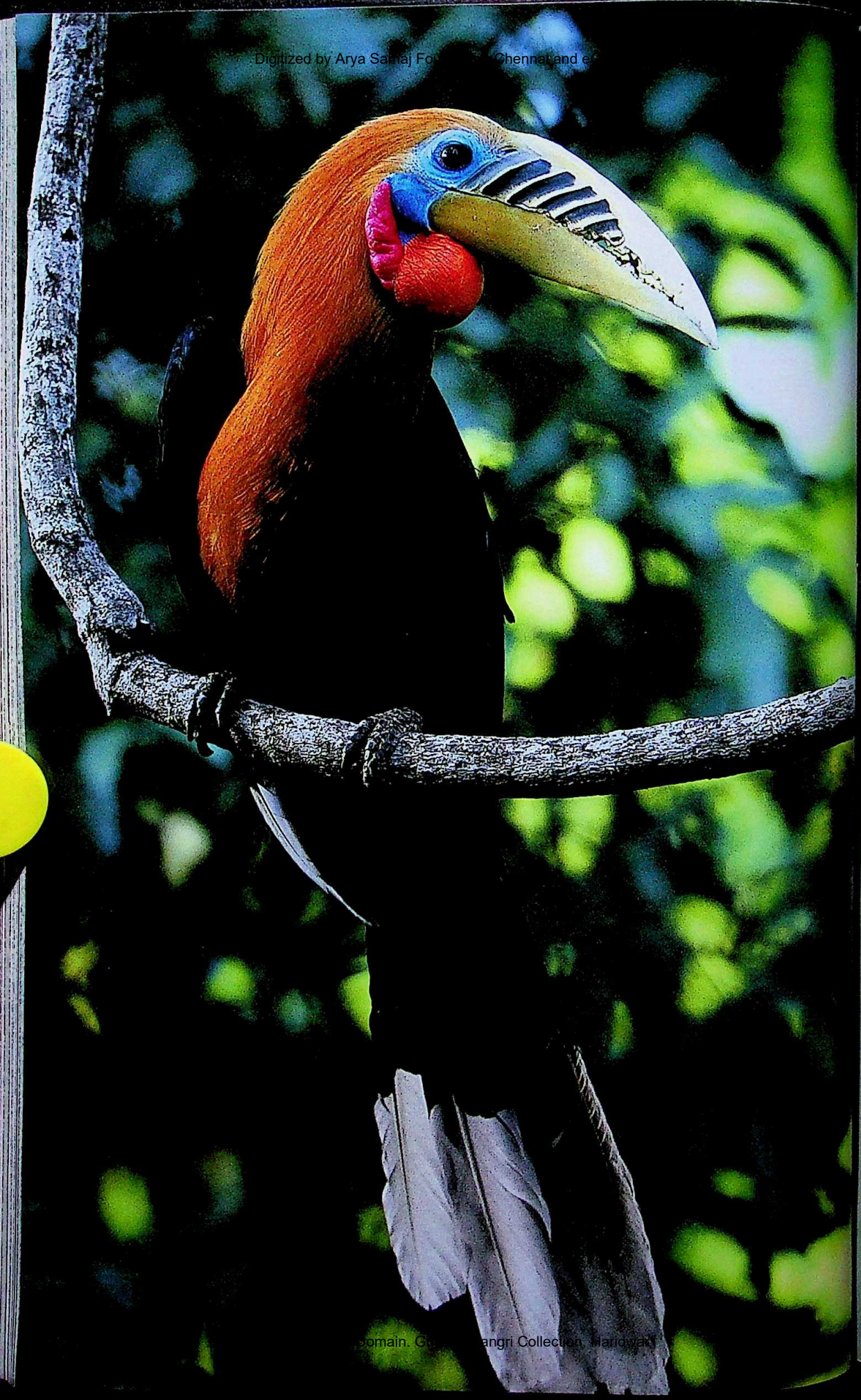

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Rufous-necked hornbill close-up

In the half-light of tropical dawn we heard the deep resonance of wingbeats draw closer. Then silence. The hornbill glided into our mist net, and suddenly his world turned upside down. Thai parasitologist Pilai Poonswad moved in quickly to extricate the rufous-necked hornbill thrashing and squawking in the net (below).

In the mountainous forests of western Thailand's Huai Kha Khaeng Wildlife Sanctuary, we had been crouched in blinds—and darkness—beneath the bird's nest tree, waiting for the male to deliver the day's first meal to his mate incubating their egg inside the tree 60 feet above.

Pilai and her team from the Thailand Hornbill Project were jubilant. This was the first time a rufous-necked hornbill had been captured by biologists, and it was a step toward learning more about this elusive species.

Once found from Nepal to Vietnam, the rufous-necked hornbill is now extinct in parts of its range and barely hanging on in others. Hunting by local tribes and habitat loss to logging and agriculture are taking their toll. In Thailand, its last stronghold, fewer than a thousand birds remain, largely in remote mountain regions.

The team first found this species in Huai Kha Khaeng in 1990. By 1998 the group was monitoring four active nests. At one, a male—unaware of being seen—flashed his near-neon colors from a canopy perch (facing page).

After measuring the netted hornbill and strapping a radio transmitter to his back, we returned him to the task of feeding his mate. Such captures will provide a bank of invaluable data on foraging range and habitat use, which will aid conservation efforts. Low on funding but high on enthusiasm, Pilai and her team are determined to raise awareness about the state of these majestic birds and give them a fighting chance.

—TIM LAMAN

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(Continued from page 60)
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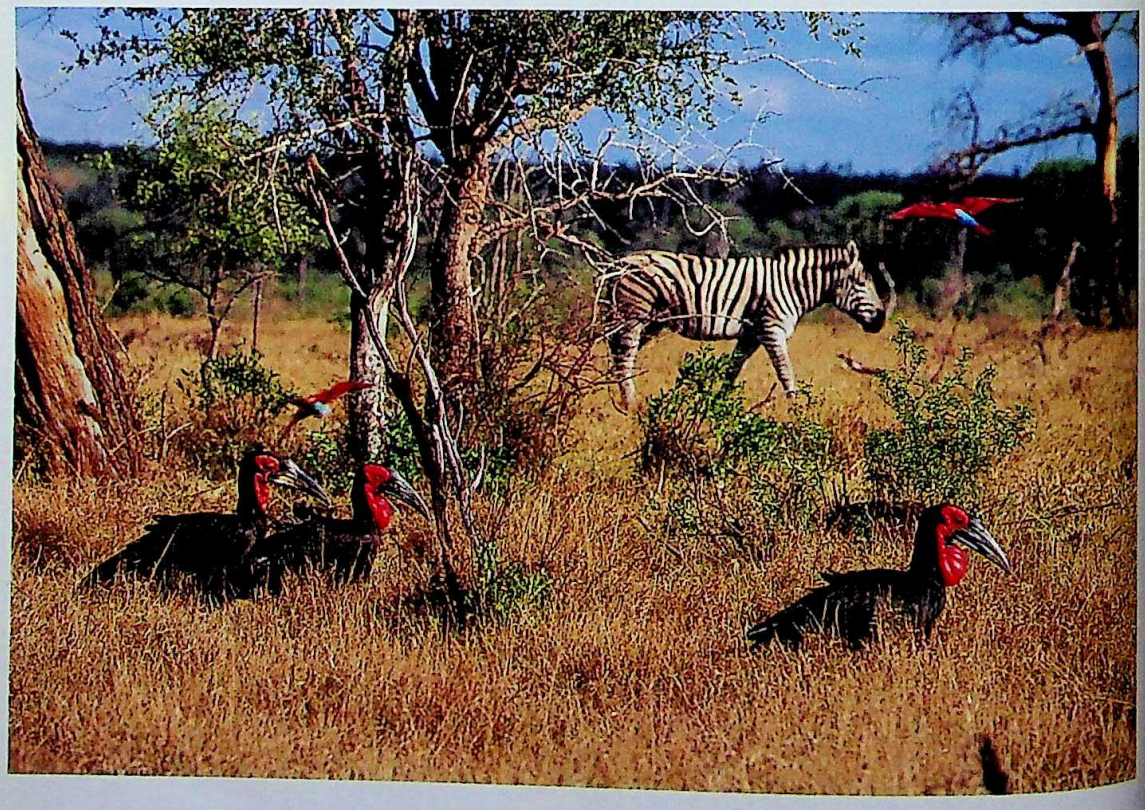
which they dis-regarded. Now he is one of a squad of Pilai's assistants in Khao Yai and other areas—financed by funds donated to her Hornbill Research Foundation—who tend nests, record calls, and collect data on the family life of hornbills.

Assisting Pilai is like assisting a tornado. She jokes that once applicants hear the job description, most disappear. Those who sign on have stories to tell. One man, sleeping on a branch of a fig tree to avoid elephants, was awakened by a cobra stalking geckos outside his mosquito net. An American volunteer full of drive for the hornbill cause turned to stone when a tiger strolled up and sniffed her blind. Boonma once encountered two of the world's most dangerous snakes in combat, a banded krait and a king cobra 14 feet long. The cobra won and devoured the krait, he says. Pilai remembers crossing a rain-swollen stream hand-over-hand clinging to a rope, while the torrent beneath nearly removed her trousers.

The next morning's sun comes up hammer and tongs, reminding us that this is the tropics and the day will burn. Entering the forest from a trailhead, I experience a delicious coolness under the green umbrella of the canopy. Immense hardwoods soar; strangler figs present an obstacle course of buttressing roots as tall as I am; liana vines dangle chaotically as if unplugged from a giant switchboard. Dry *Macaranga* leaves broad enough to accommodate a Thanksgiving turkey crunch underfoot with a noise like pistol shots, alerting, I hope, any forest creature bigger than I am.

Boonma leads, decapitating foliage and whacking vines with a bayonet-size knife. We pass piles of elephant dung, tiger scat showing evidence of a deer dinner, and several trees with bark deeply chiseled by the claws of an Asiatic black bear.

An hour later we arrive at a palm-thatch blind about 50 yards from a giant dipterocarp, a tree that can tower nearly 200 feet. Pilai points to a slit 70 feet up that reveals a great pied hornbill nest. While we wait for the male to arrive, Pilai explains that a nest cavity can begin as a tiny hole drilled by a woodpecker.



On safari in the African savanna, southern ground hornbills scan for whatever burrowing, crawling, or skittering creatures they can find. Mostly carnivorous, this largest of hornbills wields a pickax beak to hack at rodents, snakes, and even tortoises. Full lashes (right) shield eyes from sun and dust.

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Enlarged by fungus, the hole attracts a colony of bees whose honey attracts a bear, which enlarges the hole further with its claws.

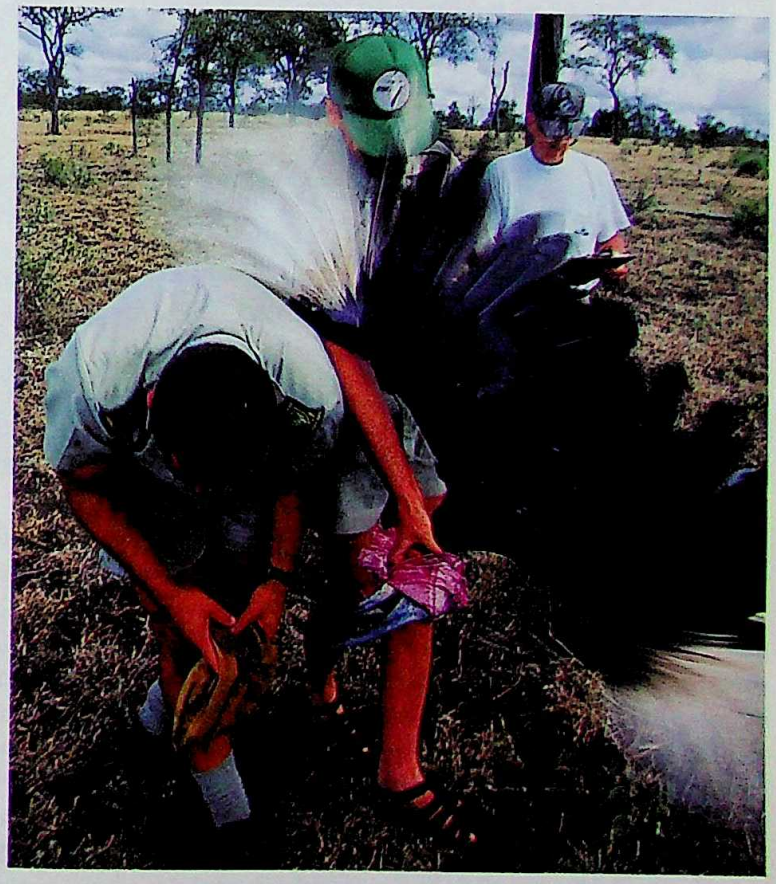
Then the cavity is ready for hornbill occupancy, and like newlyweds examining apartments, a pair checks out various cavities before deciding. There aren't enough to go around, and hornbills compete with each other and with lizards and squirrels for nest sites.

Pilai recalls a hornbill pair that discovered a monitor lizard in a prospective nest. "The male flew away and kept yelling," she said. "But the female silently went to the hole and fought the lizard, which tried to hit her with its tail. The female won, while the male backed off," she says with huge amusement. Copulation takes place during the last phase of nest building; then the female walls herself in.

I pose the obvious question. Pilai explains that mother hornbill simply backs up to the slit and defecates energetically and unerringly through it, ejecting a fecal stream that marks the ground beneath the nest. Trying to imitate, the chick will miss the slit at first, but mother picks up the droppings and tosses them out.

What about water? The answer surprises—hornbills seem not to drink. Indeed, only four species have been observed to take water, and that sparingly. "They get water from their food," says Pilai.

An hour or so passes. I hear the *wit-wit-wit* of a fairy bluebird and the scarlet—shamelessly scarlet—minivet's *ta-ta-ta.* Boonma's hammock is plump with Boonma. Cicadas whine. Flies buzz. Pilai nudges me, pointing to a tiny larval tick on her trouser leg, part of a



Unwilling subject, a southern ground hornbill tries to escape researcher Alan Kemp (above, in green cap) and veterinarian Douw Grobler in South Africa's Kruger National Park. After being sedated and measured and having his blood sampled, the male finds his way back to his lifelong mate (top left, with blue throat patch). In a reversal of roles she offers him food. Indulging in a favorite snack, a juvenile with a still mottled throat pouch nabs, crushes, and tosses back a scorpion (left).

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dual threat that confronts trekkers: dry-season ticks, wet-season leeches.

The distinctive *kok* of a great pied hornbill interrupts our drowse. Coming closer, he thrashes the air with wings spanning five feet, making the chug-chug sound of a steam locomotive leaving a station. The bird alights on a branch near the nest, checks out the neighborhood, then flattens against the tree like a telephone lineman, holding fast with claws and propped by spread tail feathers. A dark body accentuates the glorious yellow of his bill and casque, shining in the sun. Pilai has explained that each day the bird applies a gloss of yellow oil from a preen gland at the base of his tail.

He regurgitates a fig, dipping his enormous bill perpendicular so gravity can prompt the fig to roll down the inside of his beak like a returning bowling ball. He catches the fig precisely between the tips of his bill and delivers it to his mate through the slit.

Pilai has observed a male presenting as many as 150 figs at one visit. A male also offers other fruit, insects such as beetles, and animals including snakes, lizards, giant scorpions, geckos, bats, and the young of other birds. A female likes variety in her diet. "If a mate keeps bringing the same food," Pilai tells me, "she may throw it back at him."

DEPARTURE BRINGS another trek among vines and over trees fallen on the trail at precisely the angles to impede progress. We follow Boonma, who always looks like he has just stepped out of a cool shower. I stop to observe a colony of white aphid nymphs on a leaf, tiny white bodies

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Putting on a big show, southern yellow-billed hornbills—small at just 18 inches from bill to tail—defend their 40-acre territory in Kruger National Park from encroachment by others of their own kind. Their clucking calls rise in volume and tempo. At the climax the pair raise and fan out their wings and tails, bowing in unison, their world secure —for the moment.

exuding bundles of filaments that flutter in the wind. Suddenly there is a great thrashing and snapping of branches in the foliage; I see Boonma's face tighten, then relax. We have disturbed a six-foot-long monitor lizard, which has chosen to depart the area.

Over dinner that evening Pilai discusses the plight of the Thai hornbills. There is little to be done about habitat constriction, she says. It has already taken place—less than 25 percent of Thailand's original forest remains.

Pilai does what she can about poaching. One of her study areas in the south, where villagers hunted hornbill chicks for food and money, posed a challenge. "Black marketeers will pay around one thousand dollars for a white-crowned hornbill chick," she says, referring to one of the rarest of the region's birds. "That's six months' income for a villager who works on a rubber plantation." But the persuasive Pilai mounted a public relations offensive, appealing to the villagers' sense of place, heritage, and family. "If you keep taking the chicks, the birds will die out, and your children will never see them," she emphasized. "Would you want yourselves to die out?"

Thinking he might get some money from Pilai, one crafty villager said, "We will bring the chicks to you." Pilai responded, "If you bring chicks to me, I will bring the policeman to you!" The villagers have stopped the practice and now participate with enthusiasm as agents in Pilai's foundation, which has, she informs me, a hornbill adoption program.

"For $120 you can adopt a hornbill for one year," she says. "A villager will tend the nest, and we will send you pictures and report on the bird's behavior, what it is doing, what it is eating, its family life. You can even pick the species. If you visit here, we will be happy to take you to the nest."

I write a check and request a helmeted hornbill, notable for one of the loudest calls in the forest, a deep *hou-hou* that merges into a cascade of shrill *hee-hees* and a diminuendo of mocking *ha-has*. Helmeteds possess tails a yard long and are unique for their ivorylike casques. They have been observed to engage in long bouts of aerial head butting, presumably to achieve dominance, much the same as mountain sheep. I ask that my adoptee be named Melville, in fond memory of my first Editor at NATIONAL GEOGRAPHIC, Melville Bell Grosvenor, a tough yet tender visionary who was not above a little head butting himself.

Some months later I received a letter from Pilai containing photographs of a handsome helmeted perched above the nest that enclosed his mate, 80 feet up in a 130-foot dipterocarp tree on Ta Po Mountain in Thailand's southern tip. Melville's mate had walled herself in the nest, Pilai wrote. Each day Melville brought his mate an average of 48 figs plus an occasional locust, cicada, or other insect. There was also a picture of the two villagers who tended the nest and observed Melville.

Then the bad news—because of terrorist activity in the area, Thai military groups moved in, and the villagers were unable to ascertain whether Melville and his mate had fledged a chick. I'm confident they did, even if Melville had to butt a few heads. □

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THE QUEST

New England Yankees call it "the Color," as in, "the Color was better last October," or ". . . must have been that dry spell that ruined the Color." Each autumn sumacs display their leaves in a dazzling palette, competing with birches and maples. Days later, the Color is gone. Like the deep blue of an October sky or the warm orange of a winter fire, it is impossible to hold. Perhaps color's ephemeral nature motivated early humans to search out ways to possess it. They watched their fires blacken cave ceilings, daubed walls with red and yellow ocher, experimented with shells, insects, flowers, roots, and bark. They mimicked animals by painting their bodies to signal aggression, to camouflage themselves from danger, to attract a mate. Sources of color were jealously guarded. Pigments of purple, saffron, and ultramarine were, at times, worth their weight in gold. Ancient cities were built on fortunes made in part

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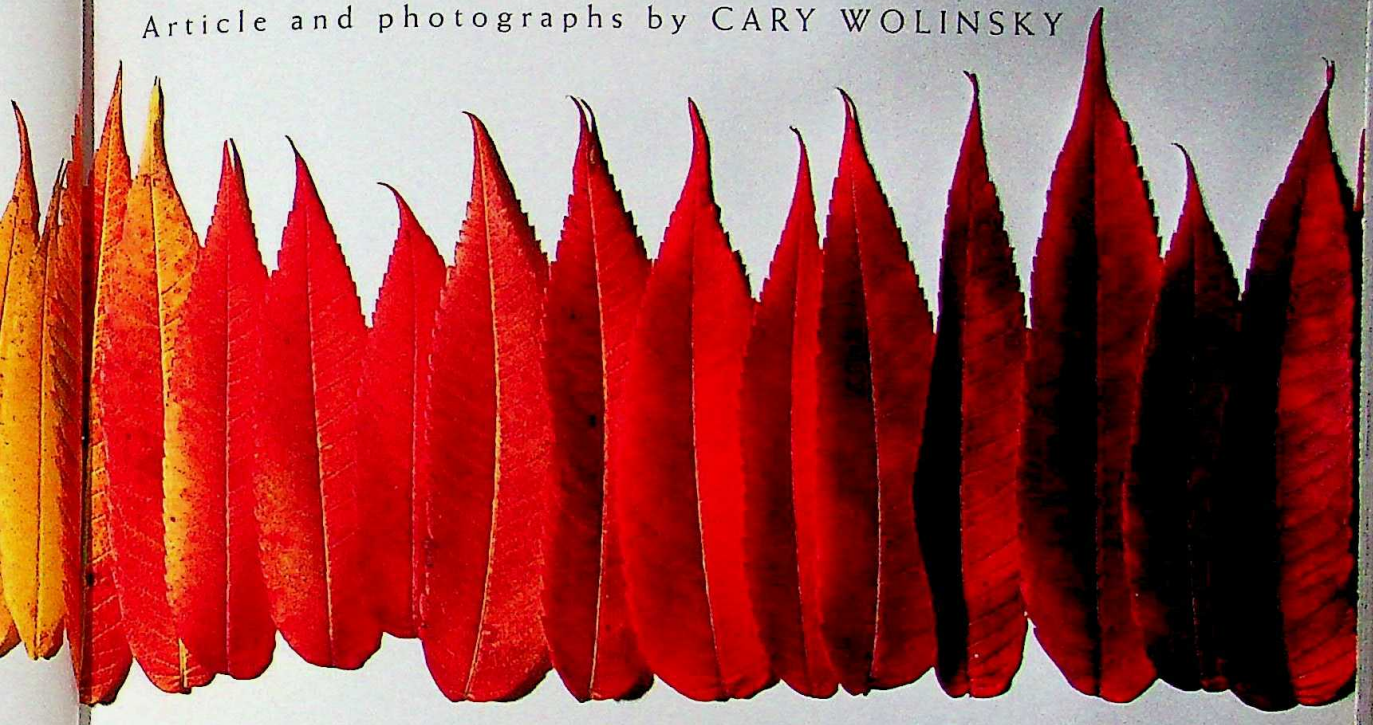
T FOR COLOR

Article and photographs by CARY WOLINSKY



from a purple dye from mollusks. In Nuremberg a man was burned at the stake in a fire made of his own imitation saffron. Ultramarine, extracted from lapis lazuli, was reverently reserved in Renaissance art for painting the robes of the Virgin Mary. In the 19th century a 19-year-old English chemistry student was the first to manufacture a synthetic dye. Suddenly the world became much more colorful. In 1907 the Lumière brothers of Paris covered a film plate with minute grains of dyed potato starch: Color photography blossomed. A crude color television, demonstrated in London in 1928, foreshadowed the glow of color in every living room. As scientists discovered the psychological influences of color, marketers manipulated consumers with the latest hues for cosmetics, fashions, and cars. Now computers have taken up the quest, imitating nature's palette in hundreds, thousands, millions of colors.

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ON THE NATURE OF COLOR

Philosophers, artists, mystics, and scientists have long debated the nature of color. For more than a thousand years India's astrologers have taught that the sun's white light is composed of all colors. Personified as the deity Surya, the sun is the single source of life and ruler of eight other celestial bodies. The bodies each transmit one pure color to Earth, affecting the destiny of every living creature.

The colors are associated with gemstones: cat's-eye, hessonite, coral, sapphire, pearl, emerald, yellow sapphire, diamond, and ruby. Examples are set out above at Jantar Mantar, the 18th-century astronomical observatory at Jaipur.

In the Western tradition Aristotle's belief that all colors are created by mixing black and white prevailed well into the 17th century. Even Leonardo da Vinci could not decide the question, declaring at different times that there were six primary colors, or eight. In 1613 Jesuit teacher François d'Aguilon declared that there were three primary colors: red, yellow, and blue, which together with white and black could be combined to make all colors.

"In the begining of the yeare 1666 . . . I procured me a Triangular glasse Prisme, to try therewith the Celebrated Phænemena of Colours," wrote Sir Isaac Newton in 1672, when making public his "New Theory about Light and Colours" (right). By intercepting a beam of sunlight with a prism, Newton proved that white light was composed of all visible colors of the spectrum and could be recombined back into white light. His ideas helped launch the era of modern optics.

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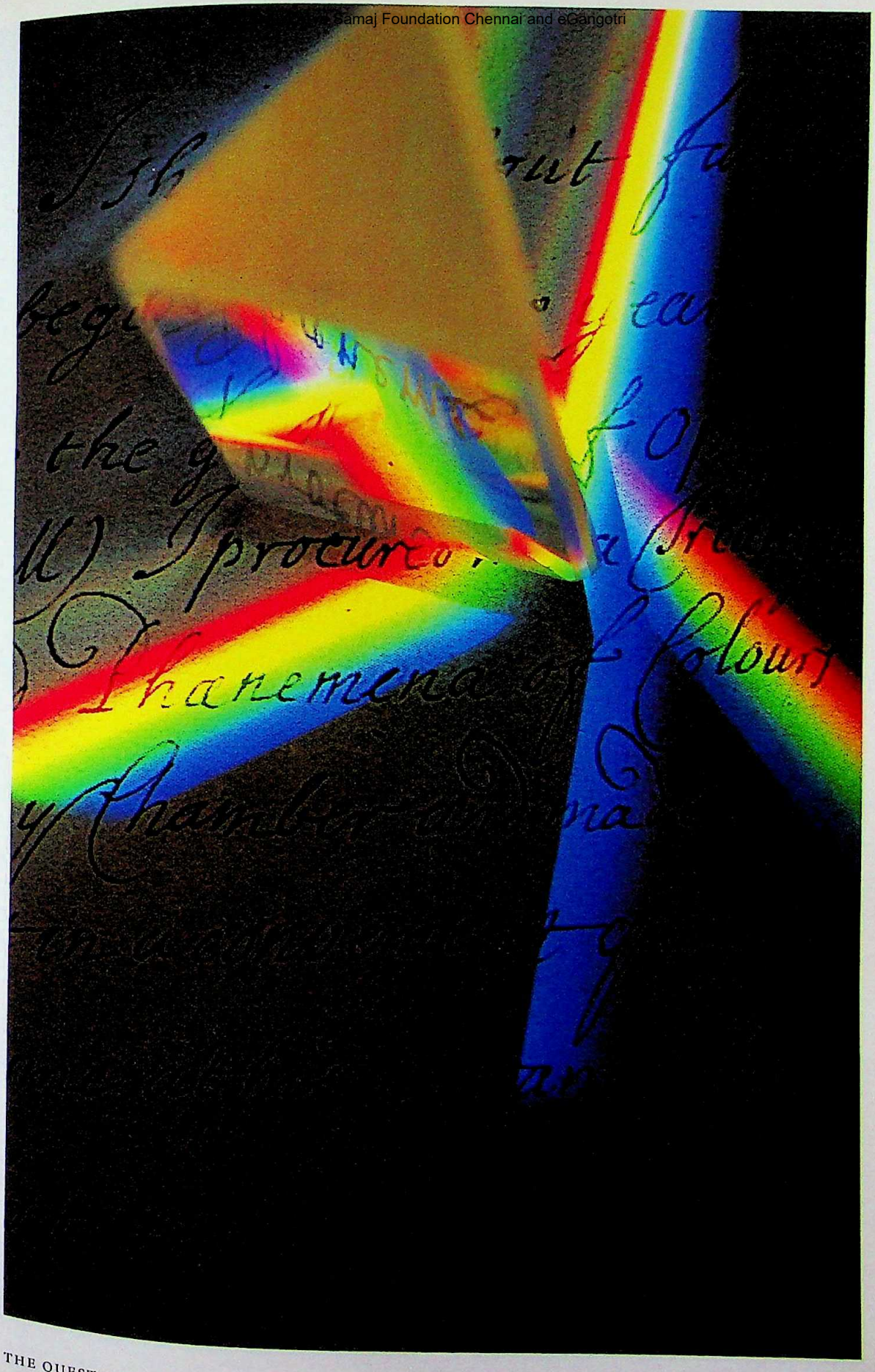

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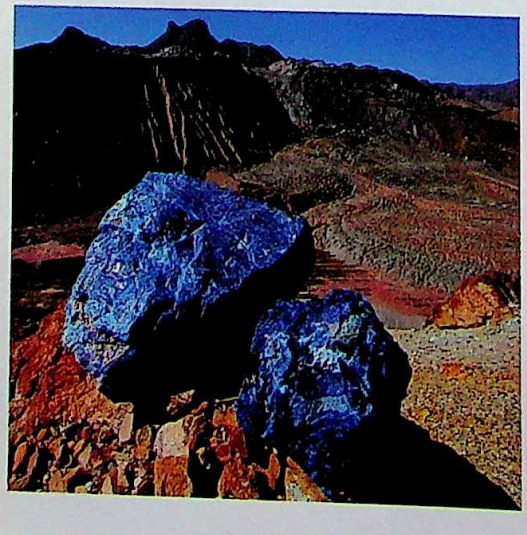
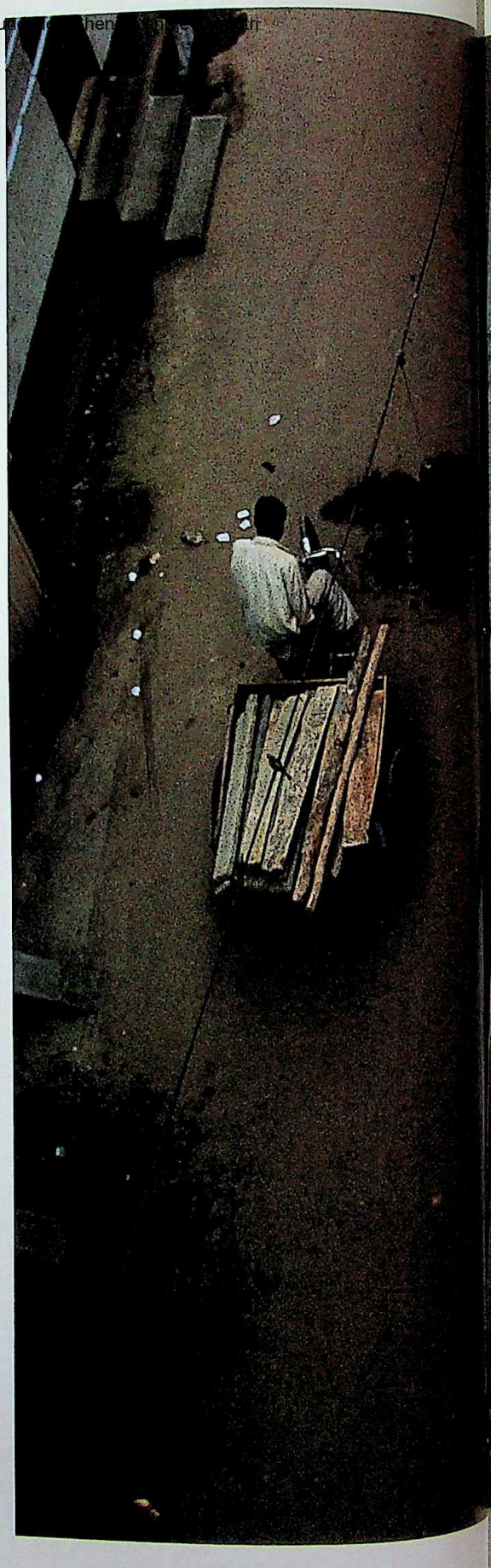
EARTH TONES

Early humans created permanent colors with natural pigments. Paleolithic cave painters used numerous minerals, including blackish manganese dioxide as well as red and yellow ocher (above). Azurite and costly lapis lazuli were later ground to make rare blue pigments. Even now, chunks of blue chrysocolla, a copper compound unearthed at a mine in Arizona (below), are sent to Germany, where they are pulverized for use as artists' pigment. Chemically produced colors that reflect specific wavelengths of light meet commercial demands for automotive paint, textile dyes, and plastics. Expensive synthetic red dye even serves tradition when diluted with cornstarch on a roof in New Delhi, India (right), for use in a festival.





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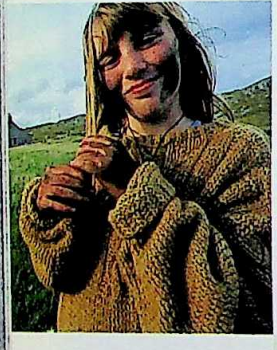
◀ To create brilliant Fiesta Red dinnerware in 1936, the Homer Laughlin China Company used uranium oxide. The color was temporarily discontinued in 1943 when the U.S. government took control of uranium for the war effort and was finally dropped in 1972.

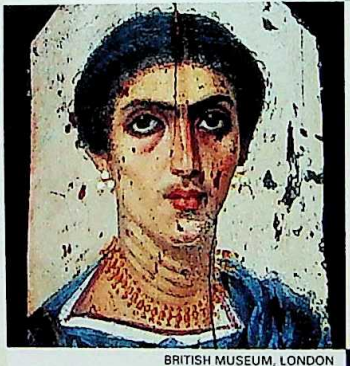
◀ In many animal species, including humans, red quickens the heart rate and causes the release of adrenaline. Men in the U.S. respond most strongly to reds with yellow mixed in; women prefer blue-based reds.

▶ "Red tape," which has come to mean bureaucratic complications, is used to bind correspondence between solicitors and barristers in England. The tape was originally dyed with safflower.

▶ The dye magenta, invented in 1859, was named in honor of Napoleon III's victory over Austria at the Lombard town of Magenta, Italy. The shade is one of the four principal inks used in color printing.



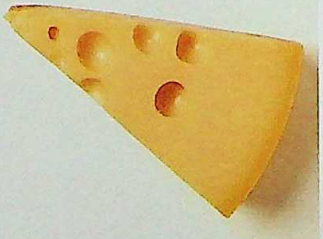
◀ Soot swept from the chimneys of peat-burning stoves is still used to dye wool on Harris in Scotland's Outer Hebrides. Peat soot produces colors ranging from light yellow-beige to deep brown.



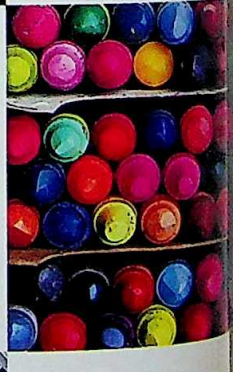
BRITISH MUSEUM, LONDON

◀ Ancient Greeks mixed pigment with hot wax to color their warships. The process was later used during the Roman period for portraits placed on Egyptian mummies in the Fayum region. Their colors remain brilliant today.

▶ Makers of traditional cheeses like Swiss, cheddar, and Gouda color their products to maintain a consistent and marketable look. But consumer preferences vary: In the U.S., Midwesterners like their cheddar orange; East Coast buyers often prefer light yellow.

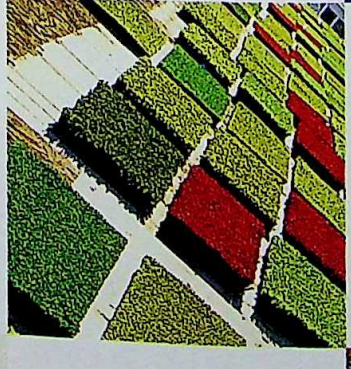


▶ Crayola: It is *craie*, the French word for chalk, and *ola*, from oleaginous (oily). Paraffin and pigment are the principal components of the more than two billion crayons Crayola makes each year.



PAINTING BY JOHN DAWSON

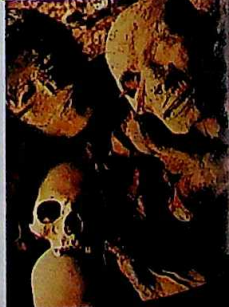
◀ Fleas in Louis XVI's palace gave the ladies of the court fits, but when one of Marie Antoinette's favorite shades was christened puce (French for flea), the name stuck. Dyers soon offered hues called belly of flea, thigh of flea, and blushing flea.



◀ Want to keep the color? Artificial turf is exposed to intense sunlight and heat in the Arizona desert by Atlas Weathering Services Group, a firm that tests how quickly numerous products fade.

▶ Campbell Soup adopted the color red in 1898 after an executive was inspired by the red-and-white uniforms of Cornell University's football team. Many companies now score points using red, which creates the illusion of advancing toward consumers.

▶ Popular with European painters for three centuries, mummy was a rich brown pigment made by grinding the remains of Egyptian mummies.



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◀ "White does not exist in nature," painter Pierre-Auguste Renoir is reported to have said. Fresh snow reflects nearly all incident light. In wind-sculpted drifts, pockets reflect the blue sky, while ridges reflect the orange of sunset.

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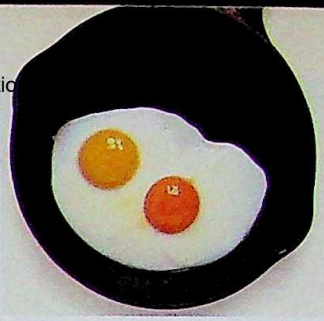
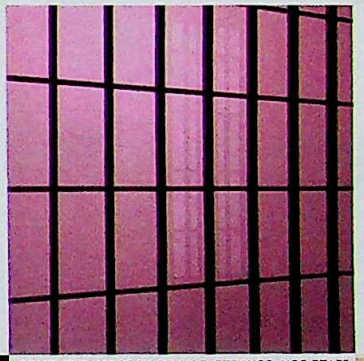


◀ Some folks are fussy about their yolks. To satisfy German preference, egg producers feed chickens marigold petals and paprika to darken the yolks. Green eggs and ham are a different story altogether.

▶ Production of Indian yellow, an artist's pigment made in India from soil soaked with the urine of cows fed on mango leaves, was outlawed because the leaves made the sacred animals ill.

▶ When chickens see blood, they peck. Red contact lenses prevent the birds from seeing that color—and thus from killing each other. The contacts are currently being tested on 100,000 chickens in the U.S.

◀ Own a color? In 1985 the courts allowed Owens Corning to trademark pink for Fiberglas insulation. However, NutraSweet was denied the right to trademark pastel blue for its Equal sweetener packets.



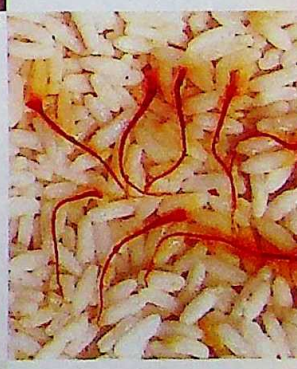
COMPUTER IMAGE BY BRIAN E. STRAUSS, NGS STAFF

◀ Inmates are reported to be calmer when held in cells painted a specific shade of pink. That same pink suppresses appetite, while orange stimulates it. Yellow surroundings may improve the performance of schoolchildren.

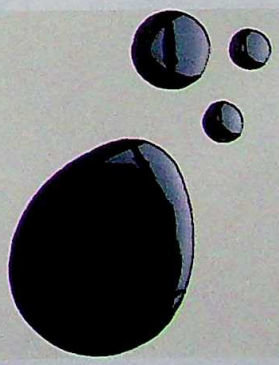
THOMAS EISNER

▶ We see a marsh marigold as solid yellow. With their ultraviolet vision bees see an entirely different pattern in the same flower.

▶ Saffron, the dried stigmas of the flower *Crocus sativus*—and the world's most expensive spice—colors risotto Milanese a golden yellow. Some 14,000 stigmas produce just one ounce of saffron.



◀ Orange, the color, suffered an identity crisis, having no name in European languages until orange, the fruit, arrived from Asia. "Orange" comes from the Sanskrit *naranga*, meaning orange tree.



◀ In 1857 William Perkin, a 19-year-old Englishman, became the first person to commercially produce an artificial dye. He had inadvertently discovered the dye the previous year while trying to synthesize quinine from coal tar (left) as a treatment for malaria.

▶ Candy manufacturers often use microencapsulated colors to avoid staining the tongue. In developing countries some people prefer having a candy-stained mouth; it boasts of disposable income.

▶ Most animals and plants get their color from pigment. However, the blue in *Morpho rhetenor* butterfly wings comes from light reflected by microscopic texture variations on colorless wing scales.

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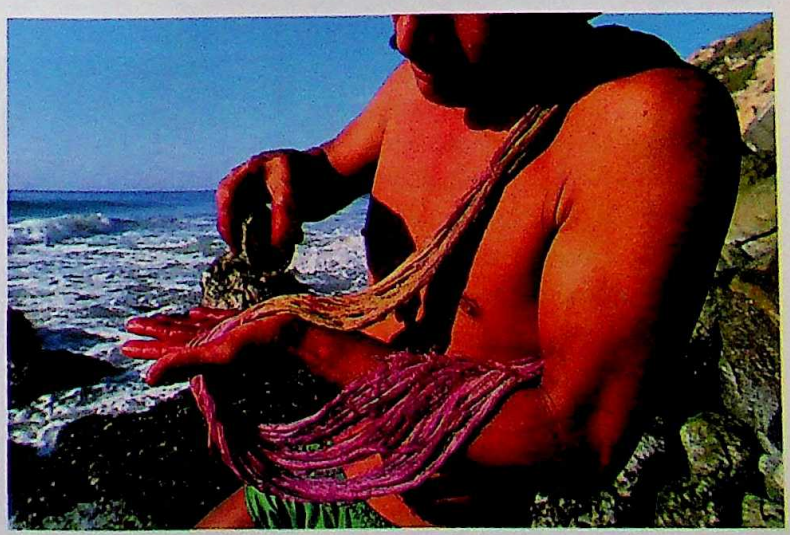
SHADES OF ROYALTY

Legend attributes the discovery of purple to the Phoenician god Melkarth, whose dog bit into a seashell that turned his mouth a rich purple. Extracted from the shellfish *Murex brandaris, M. trunculus,* and *Purpura haemastoma,* one ounce of dye destined for royal garments required tens of thousands of mollusks. Although Tyrian purple is no longer made, dyeing with shellfish is still done in Oaxaca, Mexico (right). Each winter *Purpura* mollusks are plucked from rocks. Collectors dye yarn on the spot with a secretion from the mollusks. Cloth dyed this way was once paid as tribute to Aztec rulers.

Production of the natural colorant carmine continues in the Canary Islands, where host cactuses, *Opuntia,* are "seeded" with cochineal insects (facing page). The insects encase themselves in webbing and feed on the cactuses. Harvested before they lay eggs (above), the insects are dried and crushed to extract the colorant. So in demand was cochineal that vast fortunes were made by Spanish conquerors, who held a monopoly until the late 18th century, when the French and the English penetrated secrets of the process and produced cochineal for themselves.



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COLOR FOOLS

Artfully applied touches of color turn blobs of PVC into a display sample of a Japanese *bento* meal (right). Plants "see" far-red, a color beyond human vision, as a signal to increase shoot growth. Using plastic mulch that reflects far-red (above), researcher Michael Kasperbauer tricks tomato plants into sensing competitors nearby. The tomatoes

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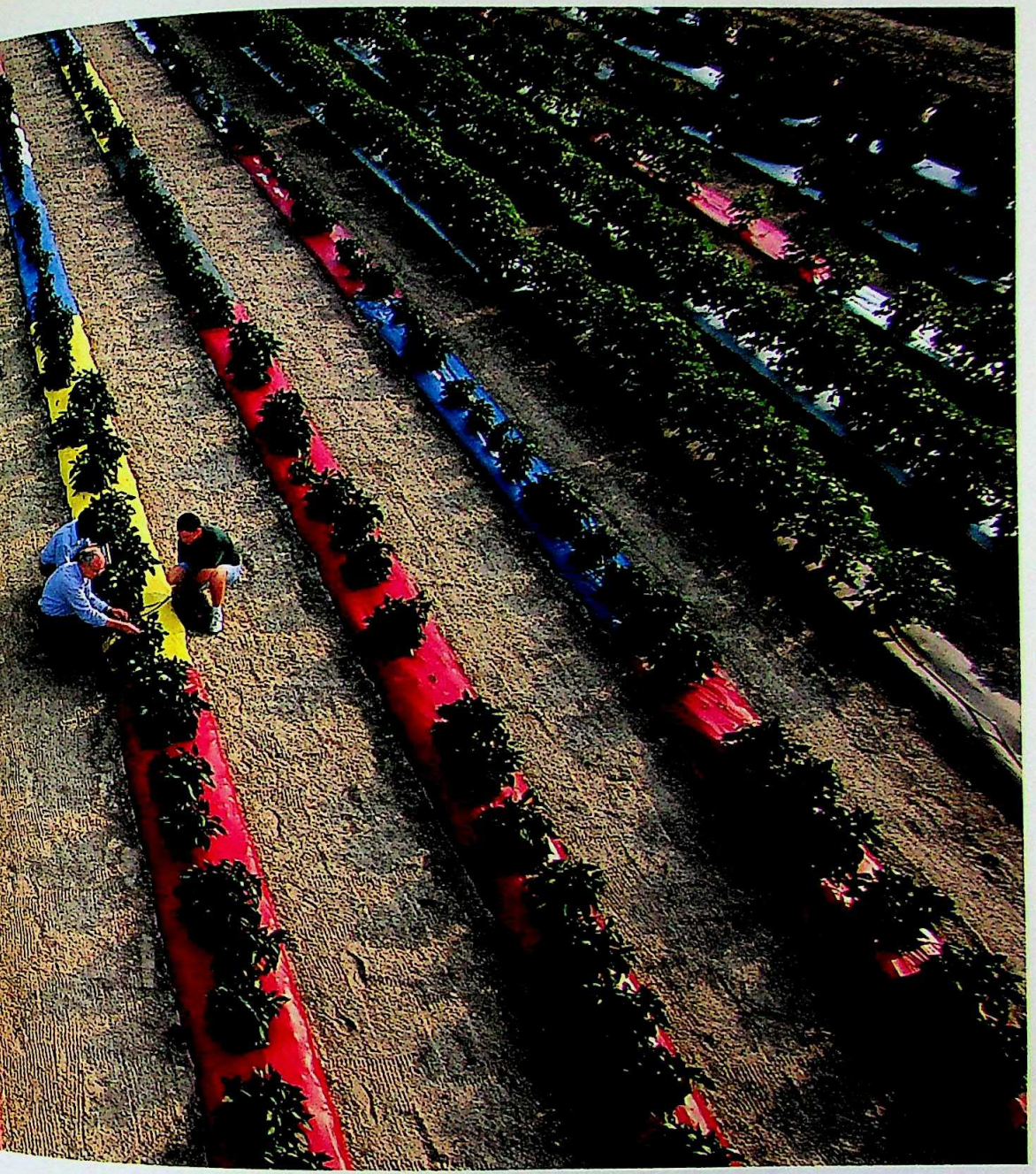

grow bigger and ripen earlier. Other colored mulches affect flavor and nutrient content.

To understand what his color-blind patients see, optician David Harris has them computer-color a black-and-white photograph (far left) in an attempt to match an original. Harris has developed lenses with special colored filters that allow the brain to reinterpret color, thus enhancing patients' color vision.

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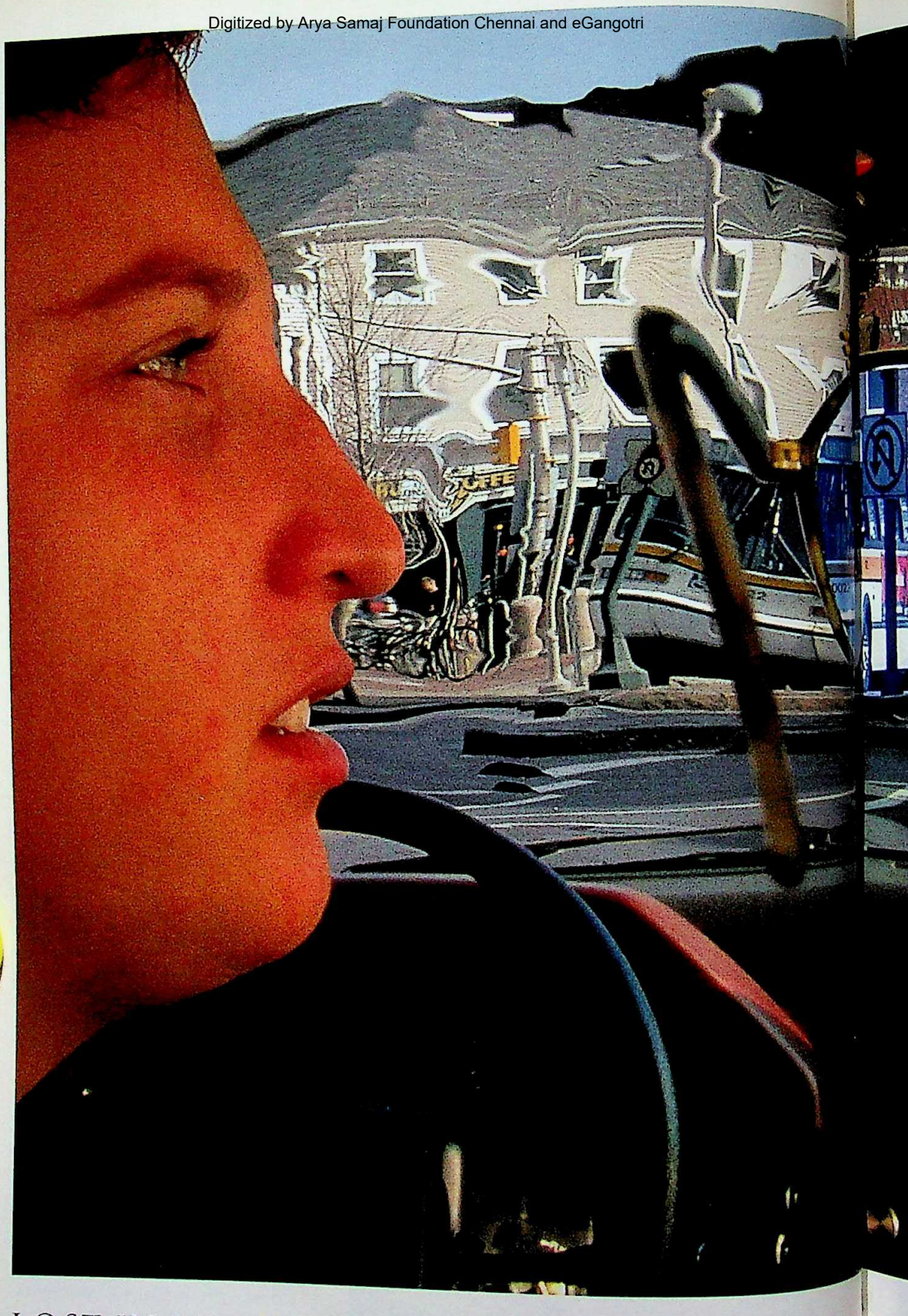

LOST IN THE NO-FUN HOUSE

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CARY WOLINSKY WITH COMPUTER ENHANCEMENT BY BRIAN E. STRAUSS

Visual distortions often plague Alex Michaels: "The road seems to buckle, buildings fold, cars come straight at me." Using computer imaging, Michaels re-creates her symptoms of scotopic sensitivity/Irlen syndrome. Blue lenses, developed by researcher Helen Irlen, help control episodes. Colored lenses also aid some dyslexic and autistic individuals.

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TONY STONE IMAGES (BACKGROUND)

HIDE AND SEEK

Cryptic coloration, or camouflage, and the ability to see in color are products of natural selection that help animals search for food, attract mates, and elude predators. Consider the pale gray peppered moth, *Biston betularia* (above, at left), here superimposed on a 1930s photograph of Sheffield, England. In pastoral times the moth was well concealed when it alighted on lichen-covered trees. With the advent of smokestack industry, soot settled on the land, and as *B. betularia*'s pale camouflage became ineffective, its numbers declined sharply. A darker form of the same species blended with the sooty background and thrived. By the 1970s English air was cleaner, and the lighter moth again prevailed.

Stalkers often use color to conceal themselves from prey. Tigers blend well with shadows and tall grass. Borneo crab spiders mimic the color of bird droppings on which their favorite insect prey feed. Arctic foxes turn white when the landscape softens with snow. Man too is skilled in the use of camouflage. On the almost treeless 78 square miles of North Harris Estate in Scotland, Jonathan Bulmer (right, at bottom) employs five ghillies, or stalkers, to assist guests who want to hunt Scottish red deer. All wear Harris tweed for a traditional purpose—camouflage, not fashion. From a distance their tweeds blend with mottled patterns created by lichen-covered stone, heather, grasses, and standing water, making it difficult for deer to see them. Each estate has its own tweed dyed to blend with local vegetation, which itself is sometimes used to dye the tweed's wool.

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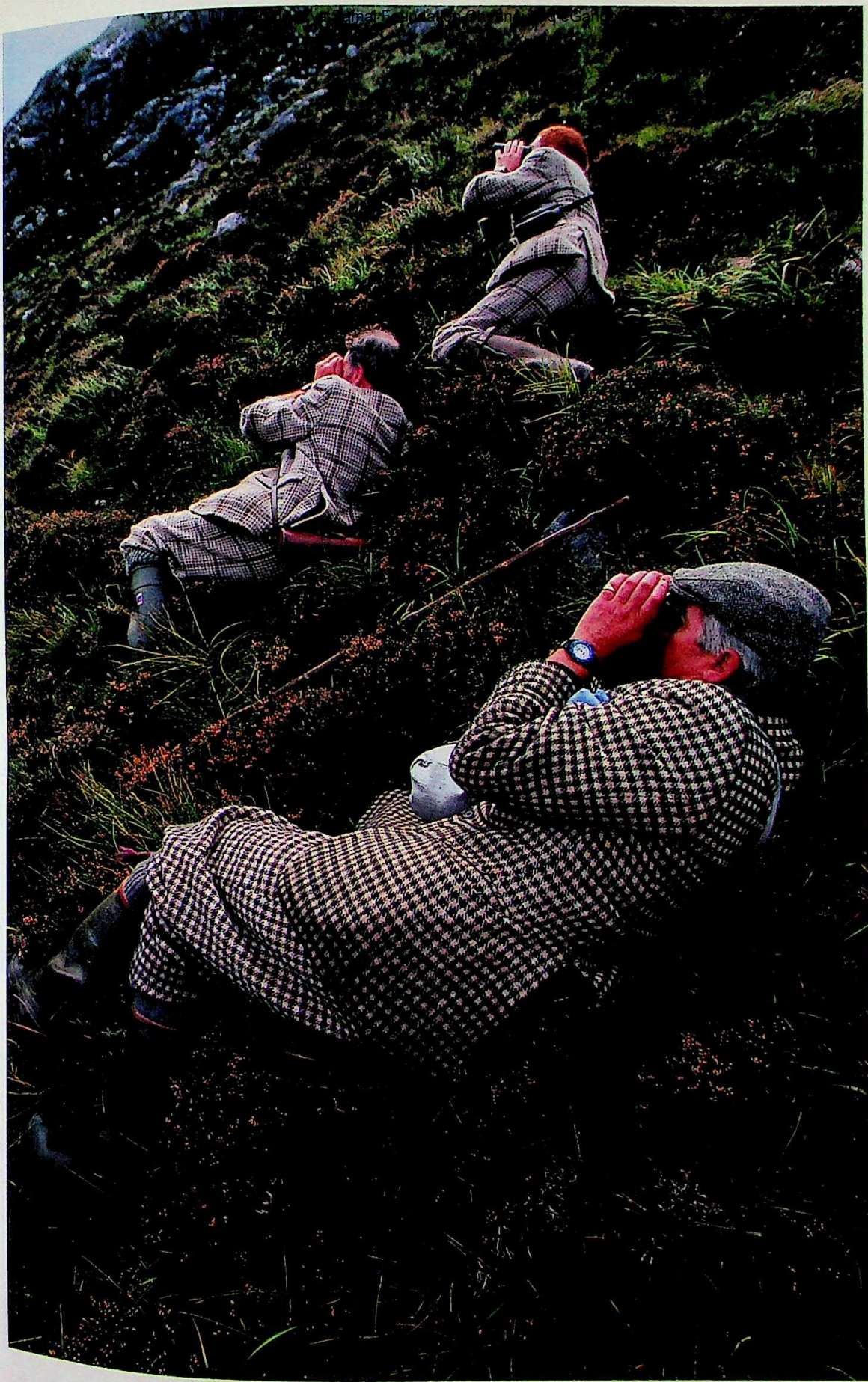

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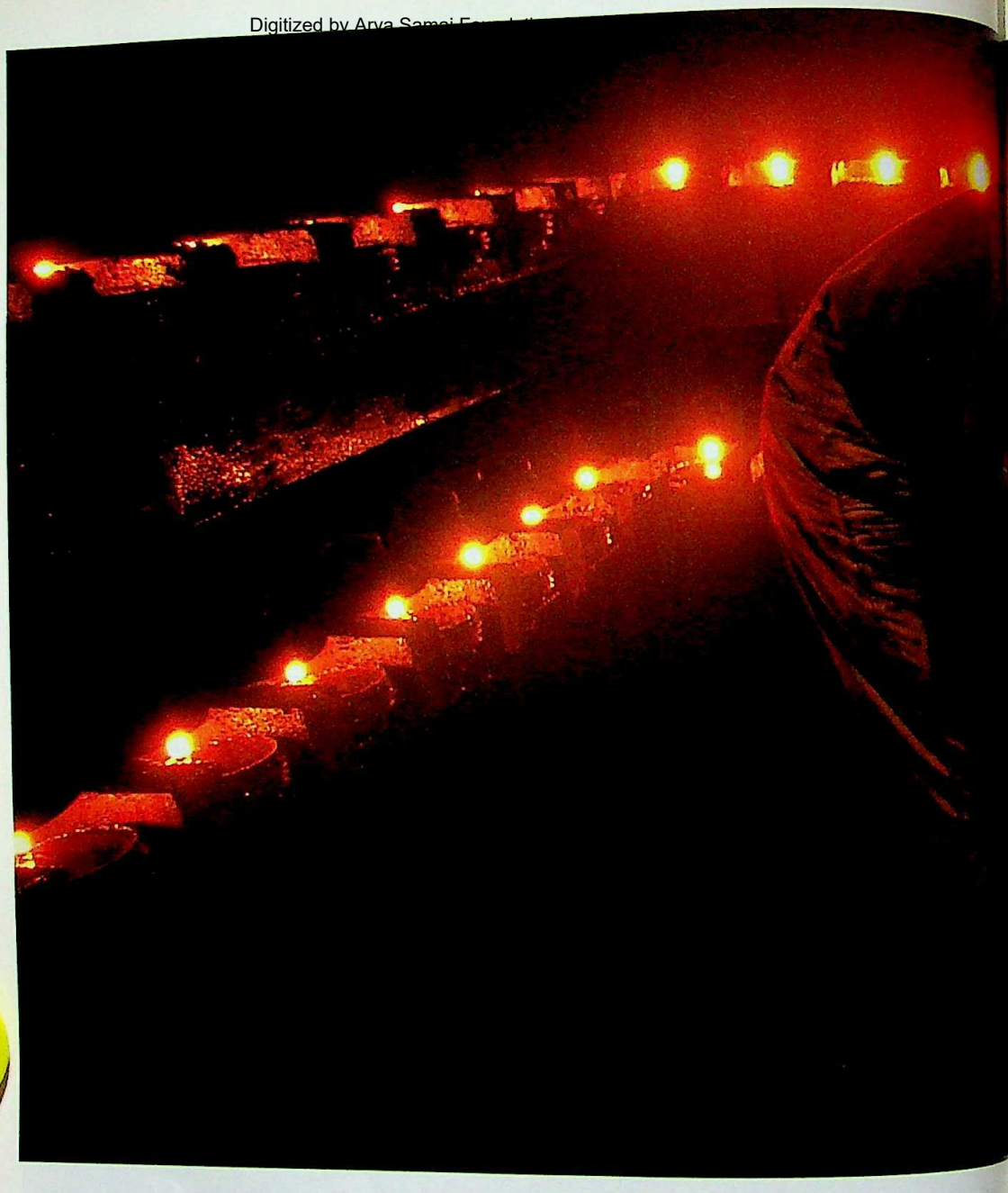

INKY BLACK

The making of *sumi*, ink sticks used by Japanese calligraphers, can be traced back at least two millennia in China, where they were made by burning pine. The Kobaien Company, a 15th-generation family business in Nara, makes one-quarter of Japan's sumi. Every two hours Yoshiro Sakaguchi enters a chamber choked with oily black

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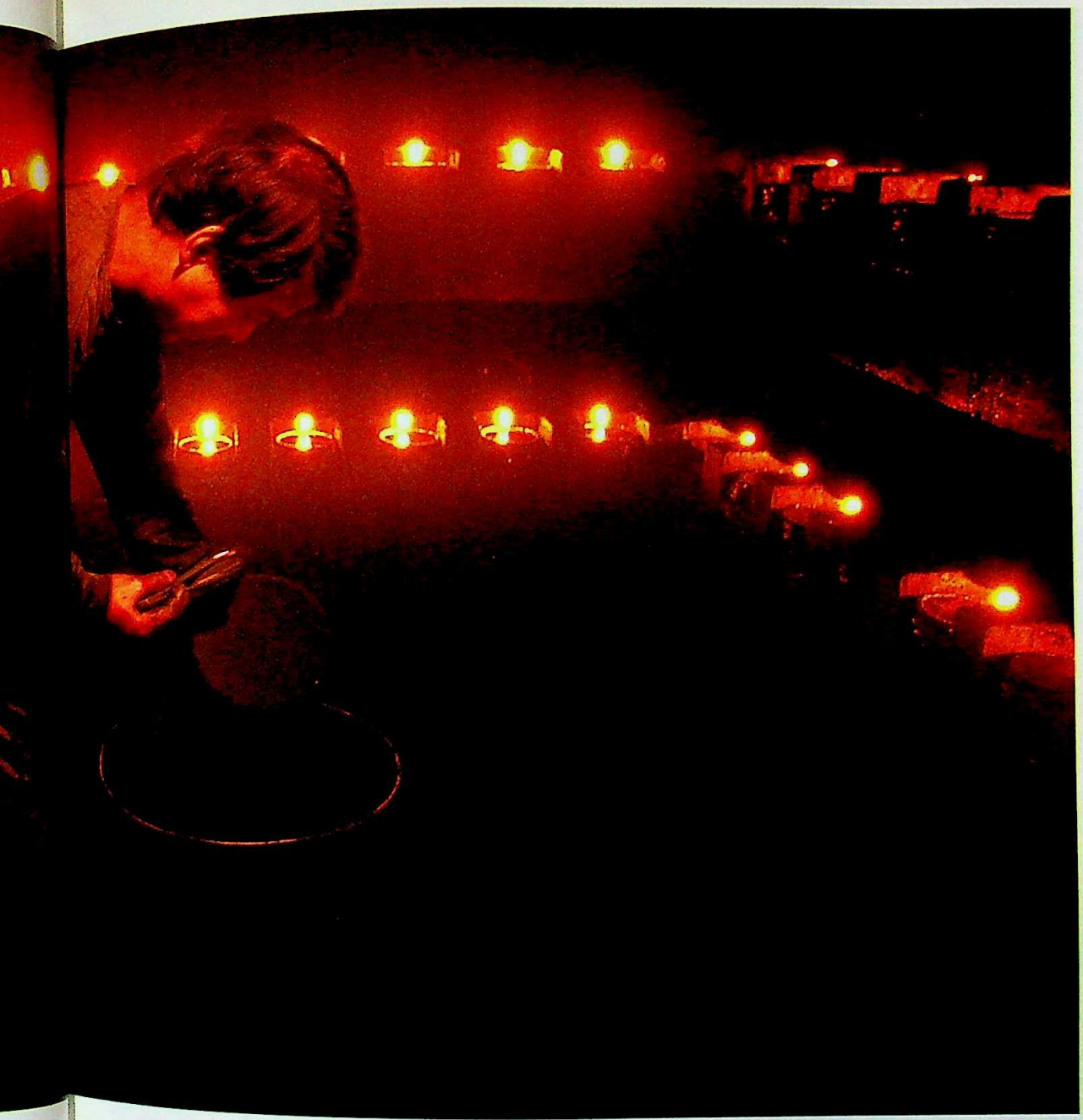

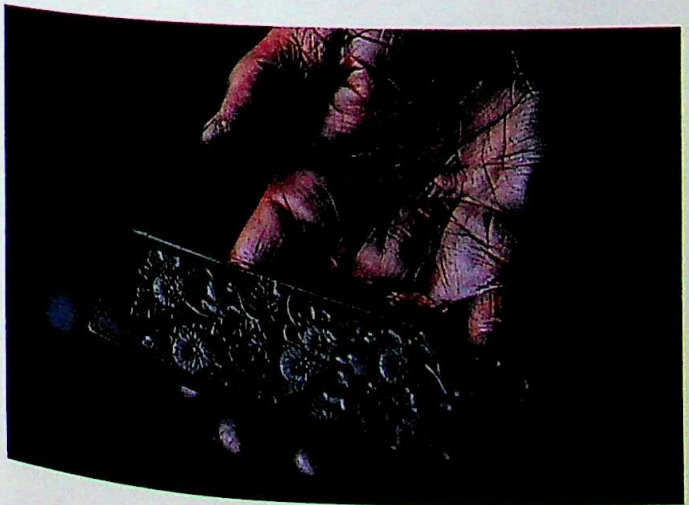

fog to brush soot from the caps of rapeseed oil lamps (above). The soot is mixed with cowhide glue and perfume. Toshitsugu Okabe kneads the mixture with his feet (opposite), rolls the material into small, soft cylinders, then presses them into decorative molds. The sticks (left) are dried slowly in damp ash and hung for as long as three months. Sumi is made only in winter, as the glue tends to spoil in hot weather.

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WHITEST WHITE

In ninth-century Japan dolls made of paper and grass were set adrift in rivers to carry off misfortune. Over time, craftsmen developed more elaborate and costly dolls for display. Oyster shells are aged for at least 20 years at Kyoto's Nakagawa Gofun Enogu factory (below), then sorted and crushed into *gofun*, a highly stable white pigment. Artists in the workshop of Chozan Kawase mix the fine white powder with animal glue and apply it in thin layers to forms (above) made of sawdust and glue. Hair is painted with sumi (preceding pages), and red is applied to lips using 50-year-old cochineal (right). Fifteen silk-adorned *hina* dolls in ancient court dress are displayed each year on Hina Matsuri, Girl's Day Festival, and may cost as much as $25,000.

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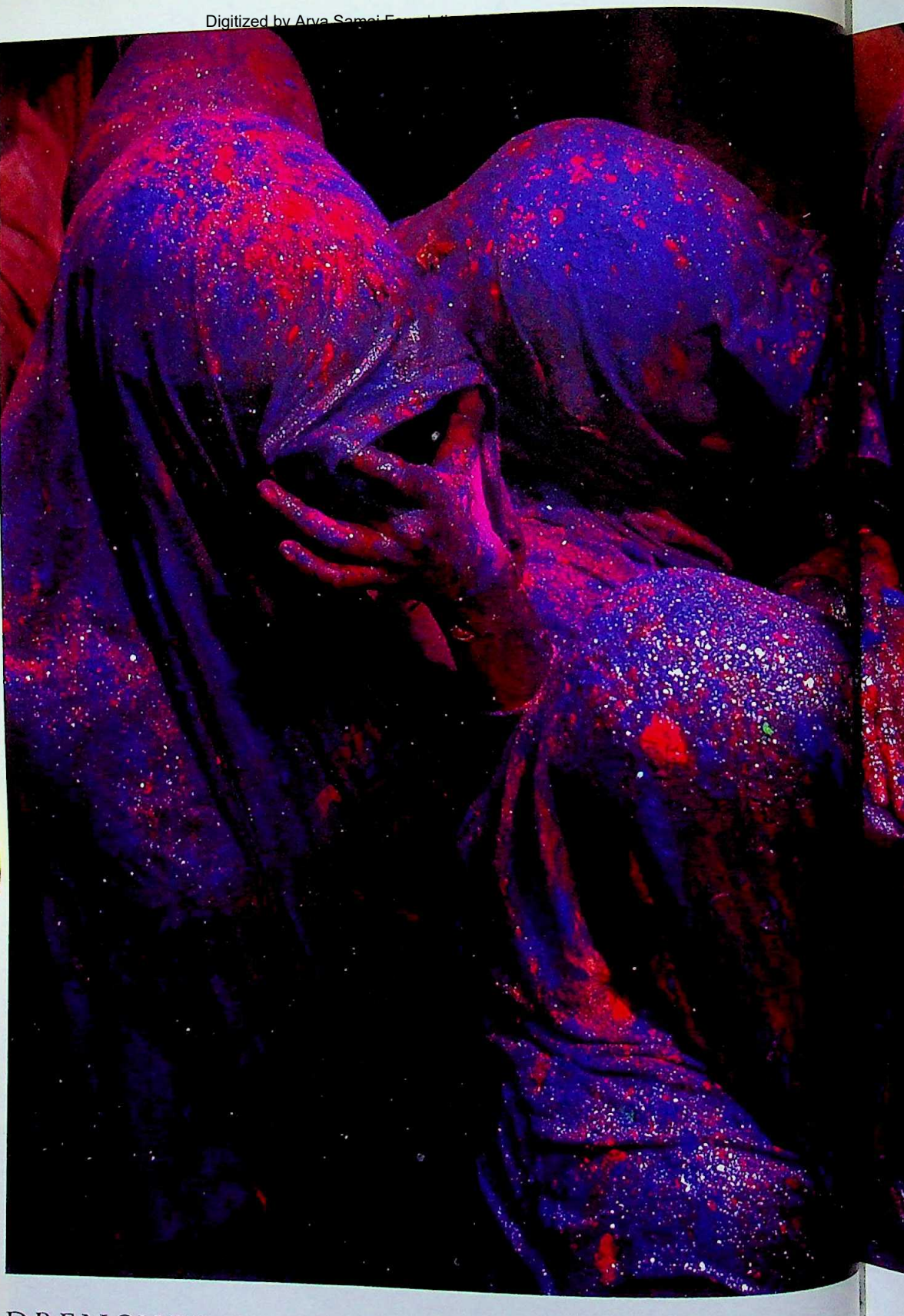

DRENCHED IN DEVOTION

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Dyes mixed in water rain on young Indian women at the Dauji Temple in Uttar Pradesh, at a festival celebrating the passion of the Hindu god Krishna for his lover Radha. In the legend, *gopis* (cowgirls) showered the couple with colorful flower petals. To Hindus each color is symbolic of a force in life.

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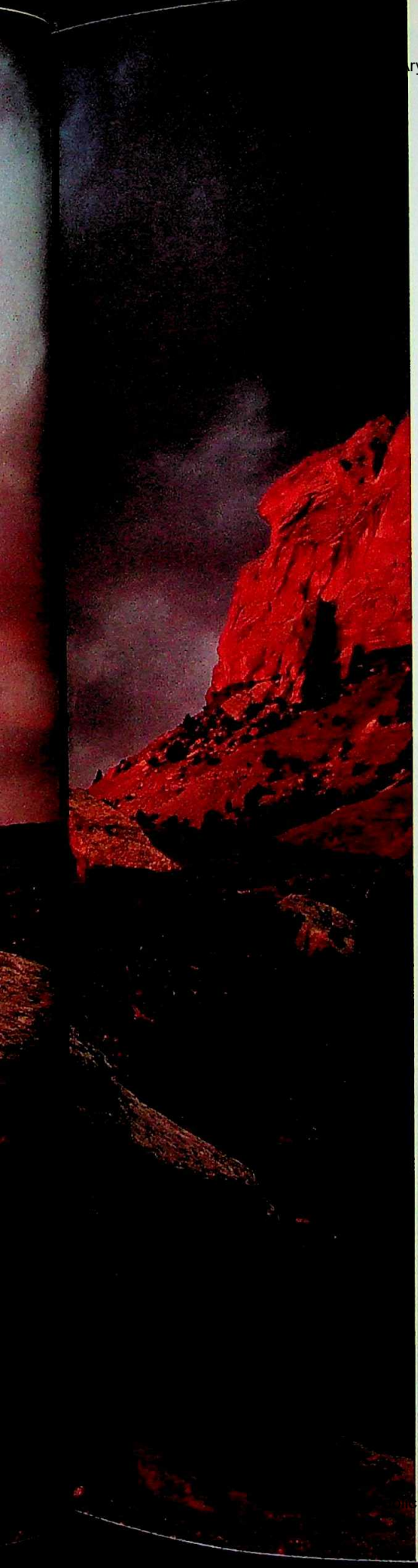

CELEBRATING CANYON COUNTRY

GRAND STAIRCASE–ESCALANTE NATIONAL MONUMENT

By T. H. WATKINS
Photographs by DIANE COOK and LEN JENSHEL

THE GHOST OF Everett Ruess, some say, still haunts the canyons of southern Utah, for it was here that he vanished in 1934. The 20-year-old writer and artist had set off from the town of Escalante with a couple of pack burros to spend some time painting and writing in red rock country. "I am going south towards the river now," he wrote his parents, "through some rather wild country. I am not sure yet whether I will go across Smokey Mountain to Lee's Ferry." Ruess was never seen again.

The young man's ghost may have been watching last November when the U.S. Bureau of Land Management (BLM) issued the first draft of a proposed management plan for the nation's newest national monument—Grand Staircase–Escalante, 1.9 million acres that Ruess probably knew as well as anyone of his time. These are acres to be managed, the BLM's plan emphasized, in such a way as to "maintain the unspoiled nature" of their much celebrated beauty.

Ruess no doubt would have approved that part of the plan. Me, I was ready to do at least a modified jig.

Storm clouds swell above the deep repose of red rock desert in Utah's Grand Staircase–Escalante, a vast addition to America's protected lands.

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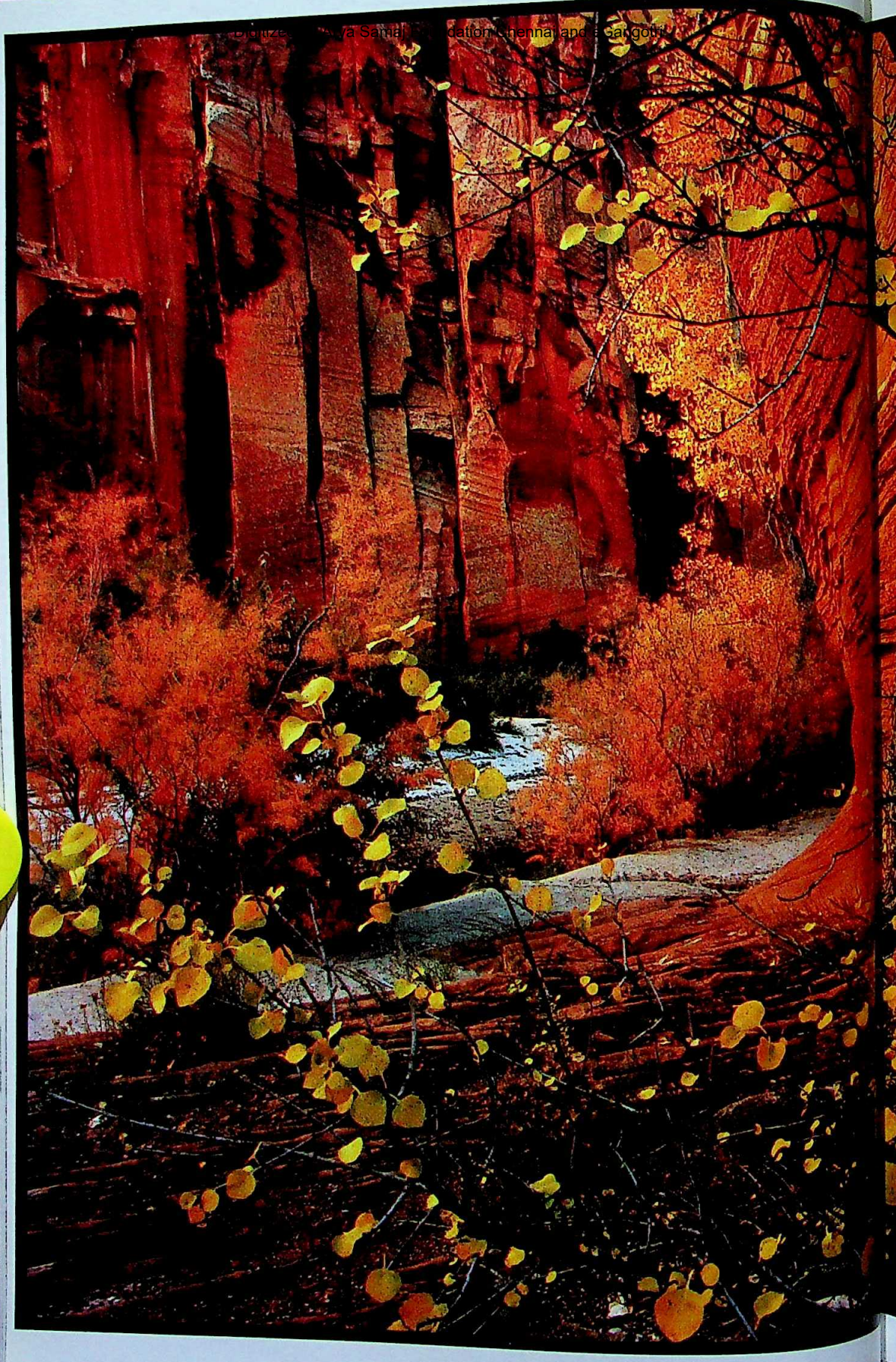

An ancient wind-creased dune, transformed to stone, forms a wall along the Escalante River, a water

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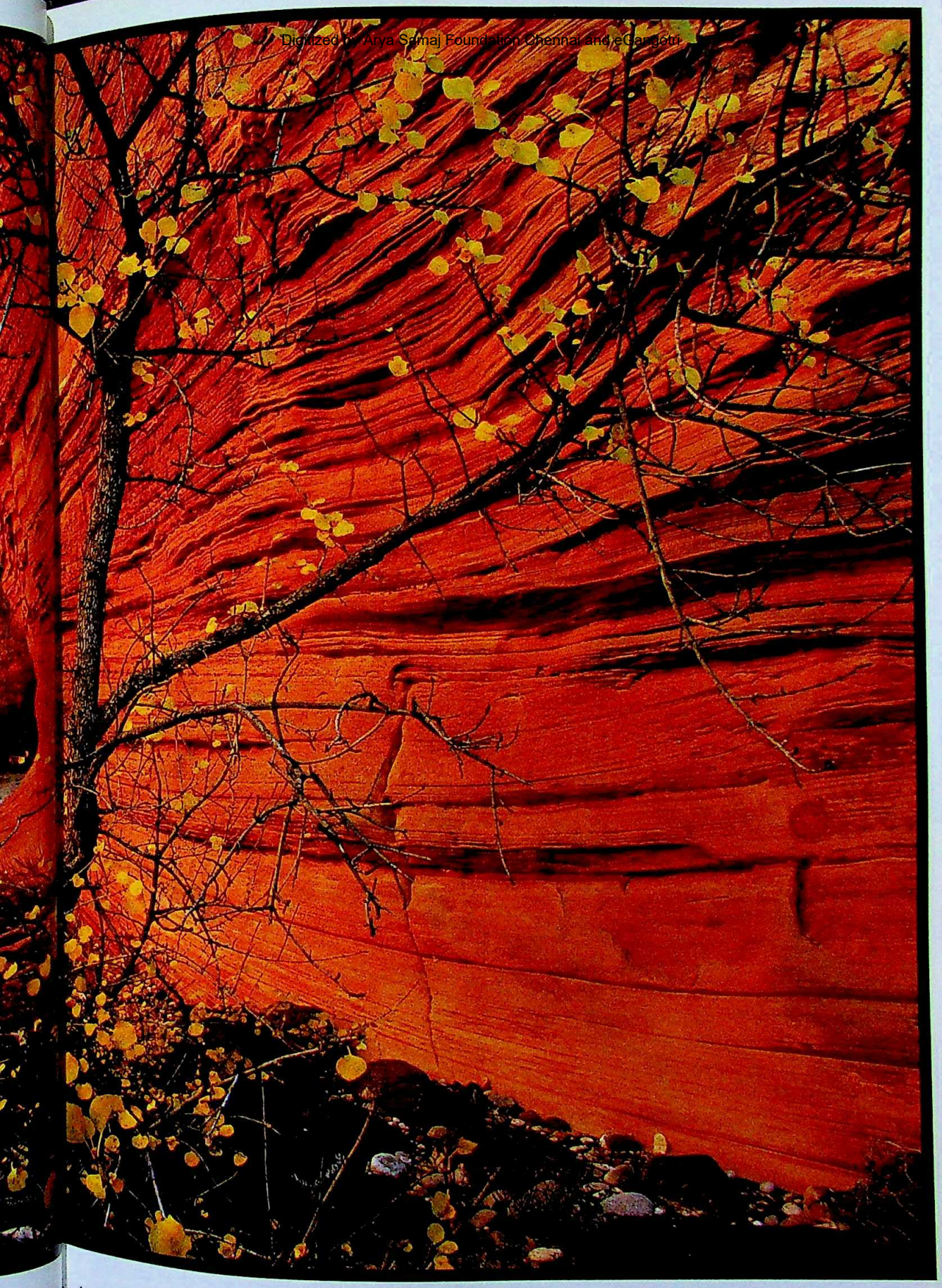

unknown to explorers until 1872 and one of the last rivers mapped in the continental United States.

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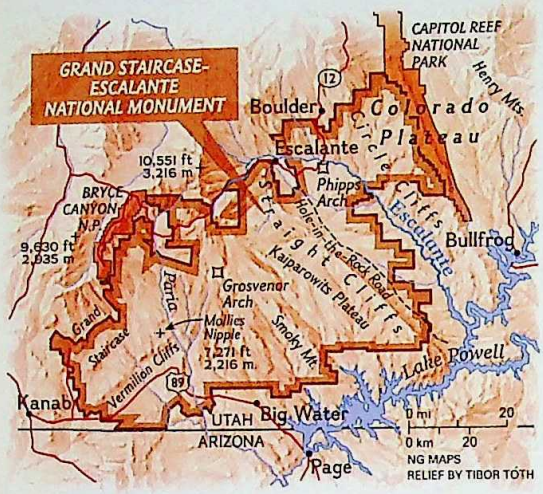
A HIGH-DESERT REALM OF TWISTING CA



The largest national monument outside Alaska, Grand Staircase–Escalante, established in 1996, covers 1.9 million acres, almost all of it backcountry with no facilities. Given only one maintained trail in an area the size of Delaware, a trekker (opposite) leaves the shadows of ponderosa pines and cuts his own path up slickrock.

I had been tracking the fate of Grand Staircase–Escalante ever since President Bill Clinton announced its designation in 1996. I didn't know the monument country anywhere near as well as Everett Ruess, but I had spent a lot of time over the previous ten years getting gloriously lost in its canyons, particularly in the northern portion, where the Escalante River tumbles down from the mountains and gathers a collection of winding tributaries on its way to Lake Powell.

For me this was red rock country at its finest, and its images remained fixed in my personal landscape: Escalante Arch, atop a 500-foot wall of slickrock; Calf Creek, its two waterfalls glimmering like braids of lace; Sand Creek Canyon, crowded with shad scale and four-wing saltbush. I welcomed the notion that the primitive condition of all the country I had experienced—and a good deal more—apparently was going to be respected by the BLM, an agency not ordinarily dedicated to the wilderness ideal. Nor was I alone in feeling that way. Remarkably, the BLM's plan was received with relative equanimity by most of the parties concerned. Somehow it had emerged, lotus-like, from a bog of conflicting visions that had once bubbled furiously with anger.

IF SOME OF US—including a lot of Utahns—had been ready to toast the President for making these lands a national monument, many were just as ready to fry him. The designation was simply an enormous landgrab, some felt, one more demonstration of the federal government's insensitivity to local needs in a state where 64 percent of the land is federally owned. The bitterness was considerable throughout Kane and Garfield Counties, the two counties in which the monument lies. After the announcement both the President and Interior Secretary Bruce Babbitt were hung in effigy. Some citizens gathered to send up black balloons in mourning. Others drove graders into a few areas of the monument and gouged out primitive roads as a demonstration of their anger.

It wasn't just the size of the monument that rankled many Utahns, it was the perceived loss of opportunity. In Kane County, for example, some citizens in Kanab felt particularly sandbagged. They had just lost a fiercely held dream (or myth, some said) of acquiring as many as 900 local jobs in a proposed coal mine. The designation of the region as part of the monument all but killed the mine proposal.

Almost immediately after Clinton's declaration, Norman Carroll, chairman of the Kane County Commission, put his official signature to "A Resolution Resulting from the Creation of the Grand Staircase–Escalante National

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T. H. WATKINS is the Stegner Professor at Montana State University and the author of a forthcoming book, *The Hungry Years: 1929-1939.* DIANE COOK and LEN JENSHEL's most recent book, *Hot Spots,* features volcanoes. This is their first assignment for the magazine.

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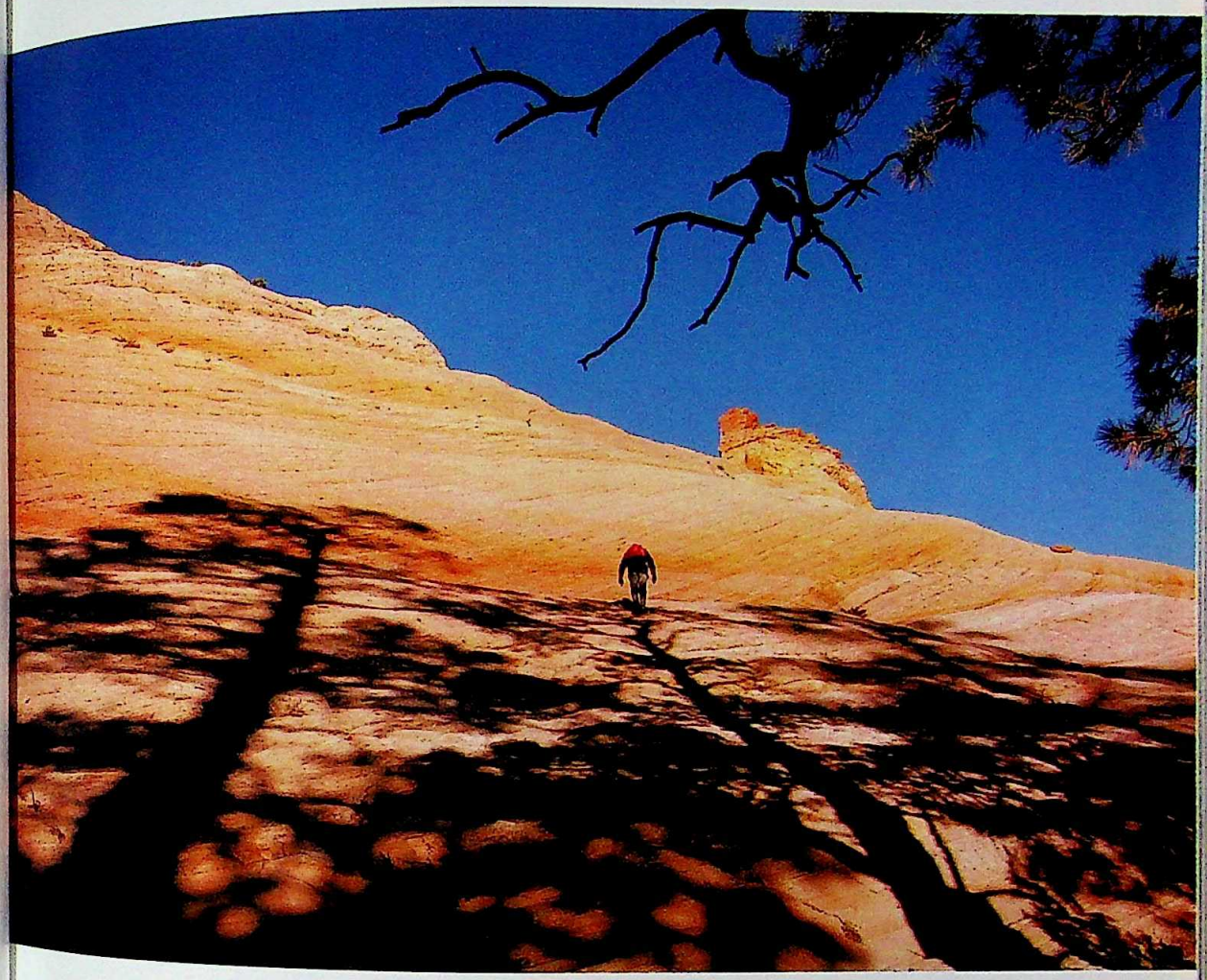
CANYONS AND SUN-BEATEN MESAS



Monument and Its Adverse Effects on the People, Lands, Resources, Economic Stability, Culture and Way of Life in Kane County." The resolution went on to direct the Kane County attorney to seek a legal strategy to overturn the presidential order. "This is beautiful country, all right, and we love it," Carroll explained to me during a break in a commission meeting in the slickrock pink county courthouse in Kanab a few months later. "But the monument is way too big."

The conflict was hardly new. Similar eruptions had followed other presidential uses of the Antiquities Act, which authorizes the President, by executive order, to establish national monuments in order to preserve "objects of historic or scientific interest that are situated upon the lands owned or controlled by the Government of the United States." Howls of anger went up among miners and commercial tourist-camp developers when Theodore Roosevelt established Grand Canyon National Monument in 1908; ranchers objected violently when Franklin D. Roosevelt created Jackson Hole National Monument in 1943; and, more recently, Jimmy Carter's designation of 15 national monuments in Alaska in 1978 inspired complaints that glowed in the dark with fury.

GRAND STAIRCASE–ESCALANTE is nowhere near the size of some of those Alaska monuments (one alone was originally 11 million acres), but there's no getting around it—this is one big place, big enough to validate the levels

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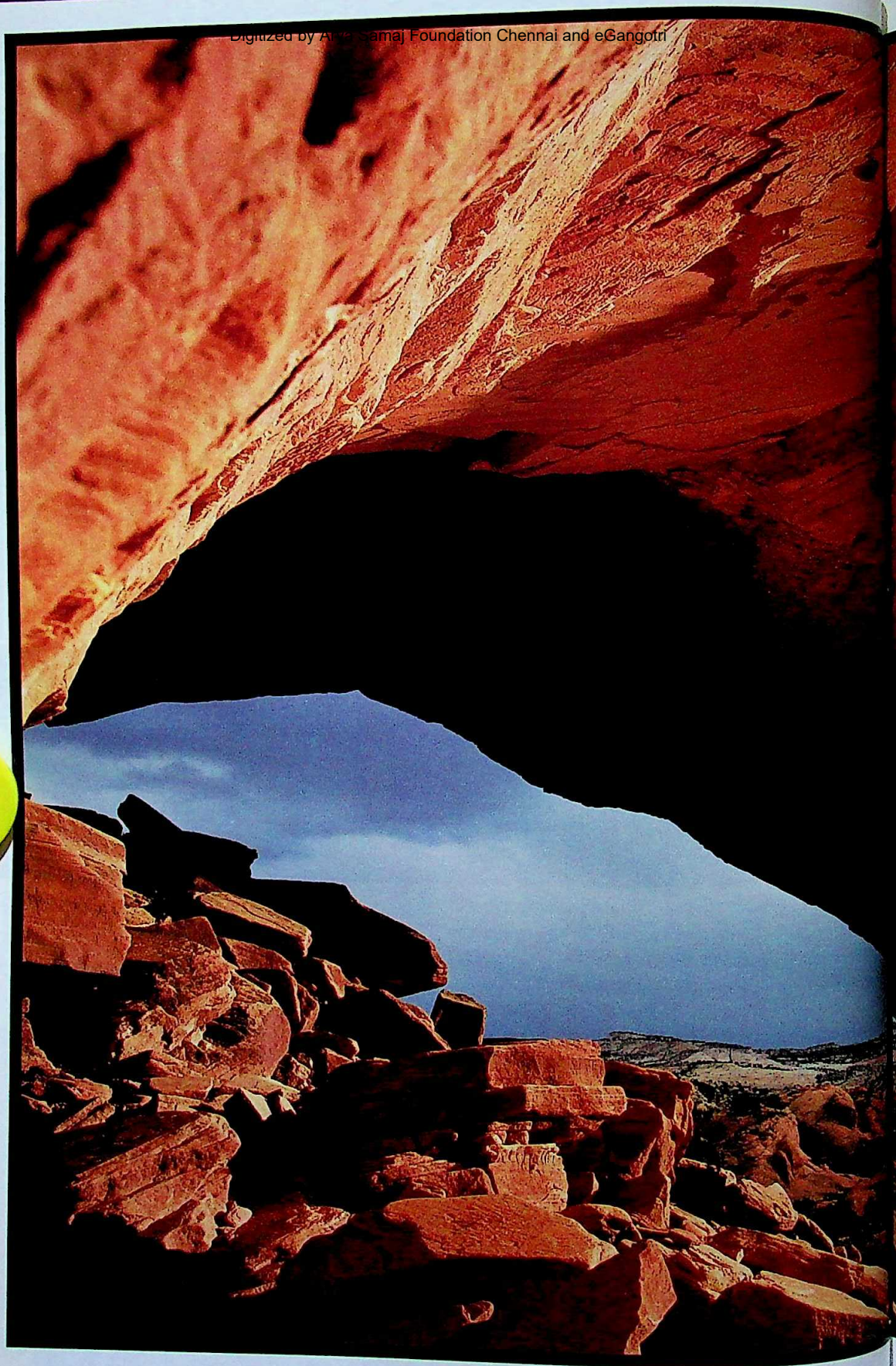

An ever widening lookout, Phipps Arch perches above country defiant of roads, bridges, and tow

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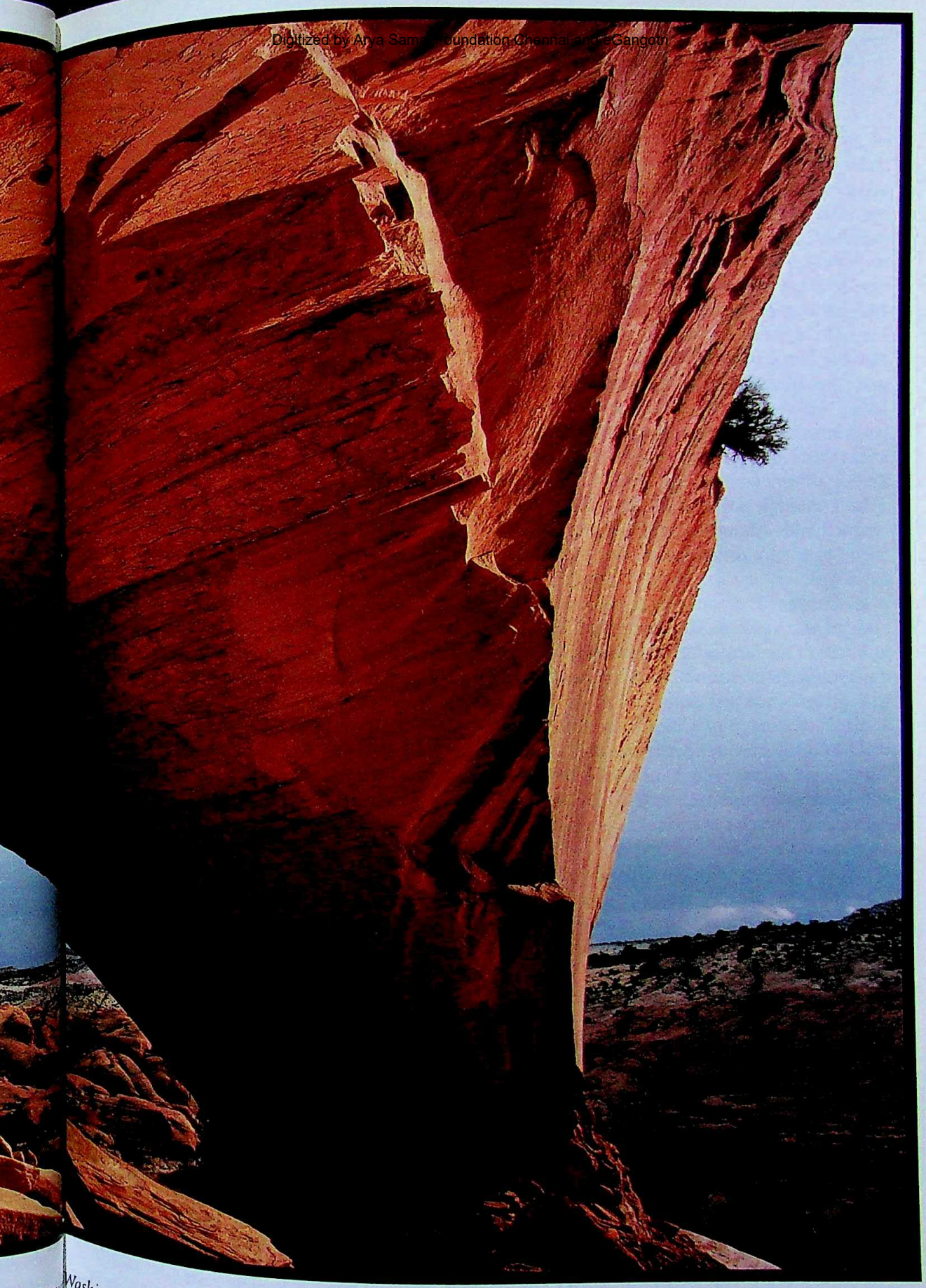

Washington Phipps, a pioneer in the 1870s, ran horses in the area until he was shot dead by his partner.

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of agitation that surrounded it. California's Death Valley, stretching across 3.3 million acres, was raised from monument status to the level of a national park with passage of the California Desert Protection Act in 1994, so Grand Staircase–Escalante is now the largest national monument outside Alaska. It embraces an enormous, amoeba-like triangle bounded on the northeast by Capitol Reef National Park, east-southeast by Glen Canyon National Recreation Area, northwest by Dixie National Forest, and west by a jagged boundary of right-angle lines that wanders north from U.S. 89 to the southern edge of Bryce Canyon National Park.

Easy enough to describe, not so easy to comprehend—though it helps if you take to the air to see it, as I did one blustery late winter day. With a weather front moving in and snow-burdened clouds already kissing the brow of the Aquarius Plateau, our small plane jumped off the tarmac of the one-strip airport outside Escalante and set off with an intrepid whine on a heading straight for the Circle Cliffs on the edge of Capitol Reef National Park, 30 miles away. Below us stretched a tapestry of mesas and benches forested by stands of piñon and juniper (P-J forests, most southern Utahns call them) and blanketed here and there by big patches of snow. Almost everywhere, the benchlands lay sliced with canyons—deep wounds that millions of years of flowing water have carved into a quarter billion years' worth of multicolored sandstone deposits.

The wind that was bringing in the storm clouds from the southwest had cleaned the air of desert haze. The winter sun, hanging low, cast shadows that defined the contours of the land with knife-edge clarity. Weeks of intermittent rain and snow had left everything damp, which intensified the colors of the land as if God had slathered it all with coats of fresh paint, giving the landscape a luminous character that continued as we swung southeast along the border of Capitol Reef, beyond whose lumps and curling canyons rose the snowy peaks of the Henry Mountains.

Then we turned southwest, along a route

A pretty poison, woolly locoweed, flowering during autumn, can make cattle that eat its toxic leaves go berserk and die. Hikers face their own dangers, from rockfalls to heat exhaustion. "This is not cheap scenery," wrote a visitor. "It must be bought with time and sweat."

that approximated the border between the monument and Glen Canyon Recreation Area, over Pioneer Mesa, Little Death Hollow, Big Bown Bench, Harris Wash. Just ahead were the Straight Cliffs, an abrupt, 1,500-foot wall that runs almost uninterrupted 50 miles from Escalante Rim to just above Lake Powell. Vaguely parallel to the cliffs was the Hole-in-the-Rock Road, a rough 60-mile road established in 1880 by Mormon pioneers on their way to set up shop in the cottonwood groves of Bluff on the San Juan River. They had to cut their way down the cliffs to cross the Colorado River to do it though, and I admired the stubborn toughness of the people who had settled this unlikely country, determined to outlast their predecessors, the Anasazi. I wouldn't bet against them either.

Over the Straight Cliffs now and on to the Kaiparowits Plateau, a wide and confusingly intricate jumble of benches at an average elevation of 6,000 feet, covered in P-J forests

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"...ROUGH, KEEP IT DIFFICULT TO ACCESS."

—KATE CANNON, BLM

and shaped everywhere by canyons, gulches, and washes. The Kaiparowits has the reputation of being the most isolated place in the lower forty-eight, and it was easy to see why as I looked out over a thousand square miles on which we modern humans had made hardly a mark.

There was a mark on Smoky Mountain though, a dirt road that twisted its serpentine way 800 feet up the side of the mountain and across the southern benches of the Kaiparowits. We could see the road from the air, and I knew it could stop your heart, because I had just been on it with Ken Rait, who was then with the Southern Utah Wilderness Alliance (SUWA). This part of the monument was new country to me, so Rait had spent two days showing me some of its high points along mud-slick tracks that threatened to send our four-wheeler sliding into sundry declivities.

After one particularly long, slithery ride and a short hike, Rait had stood me at what he called a "power spot" overlooking Paria and Hackberry Canyons, an area that fell away beneath our feet in a spectacular complex of eroded pink, red, maroon, ivory, and white sandstones, their elegant convolutions rivaling those of Bryce Canyon National Park or Cedar Breaks National Monument. In the middle distance the tall white volcano-like cone of Mollies Nipple rose from the top of a bench, and on the far horizon I could see the huge snow-shouldered hump of Navajo Mountain. "If you tell anyone how to get here," Rait said, "I will have to kill you." I was touched by his notion that I could ever find my way back here again, much less tell anyone else how to do it. Later, we tried to get up Cottonwood Wash Road, a dirt track that begins near Big Water on U.S. 89 and runs north to Cannonville on Utah Highway 12. "One of the most beautiful areas in Utah," Rait said. But as we turned off U.S. 89, we found a sign planted in the middle of the road warning us it was impassable. Someone had spray-painted an addendum: "Deep Ruts, Complete Washouts, No Californians." It didn't sound promising. We retreated.

Now, in the air beyond the Kaiparowits, the pilot headed us toward the edge of the Grand Staircase. The name is a little misleading. It certainly confused some tourists shortly after designation of the monument. Just how high were the steps of the staircase, they asked a ranger in Canyonlands National Park, and how long would it take to walk them?

Quite a while. The "staircase" in fact is a series of random cliffs that pile up in fits and starts north of the Kaibab Plateau above Grand Canyon, the result of millions of years of fracturing, faulting, lifting, and shoving as the Rubik's Cube of the Colorado Plateau assembled itself. It would be a 40-mile "walk" up more than 5,000 feet of elevation from U.S. 89—up the "steps" of the Vermilion Cliffs, the White Cliffs, the Gray Cliffs, and the Pink Cliffs until you reached the top of the Paunsaugunt Plateau, where Bryce Canyon National Park resides—even higher and farther if you shifted a little east toward Powell Point or beyond that to the Aquarius Plateau.

We did not walk, we flew, the pilot and I, watching the disorganized, overlapping, colorful mix of cliffs and plateaus unroll beneath us as we raced the storm clouds back to the Escalante airstrip. America's new monument, I reflected, was indisputably big—big and wonderfully various. But was it big and various enough to satisfy all the visions people had for it?

THE BLM had just started its mandated three-year planning process for the monument that March of 1997, and there were plenty of people who intended to take full advantage of the government's call for public participation. Many of those I talked with, like Allen "Viv" Adams, then mayor of Kanab, told me that most of the monument's now primitive roads should be paved so that tourists could get to its wonders with a minimum of effort and that there should be visitor facilities, including campgrounds, RV hookups, and toilets. Others, like Garfield County Commissioner Louise Liston, were less enthusiastic about paved roads and facilities but said that mining, including coal mining, oil

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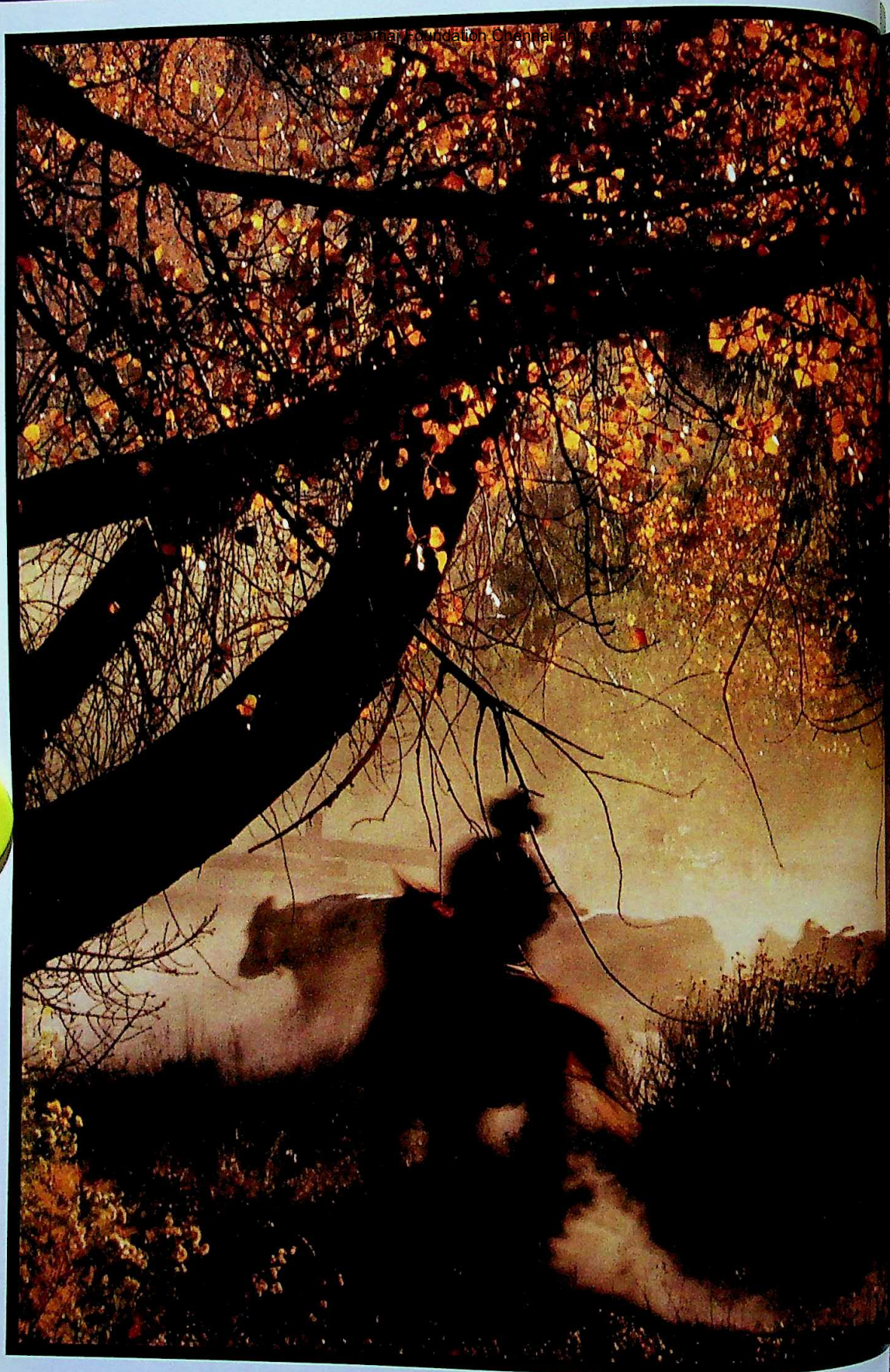

When the dust lifts, Dell LeFevre will have ended his last cattle drive to the Escalante River, now off-li[mits to catt]

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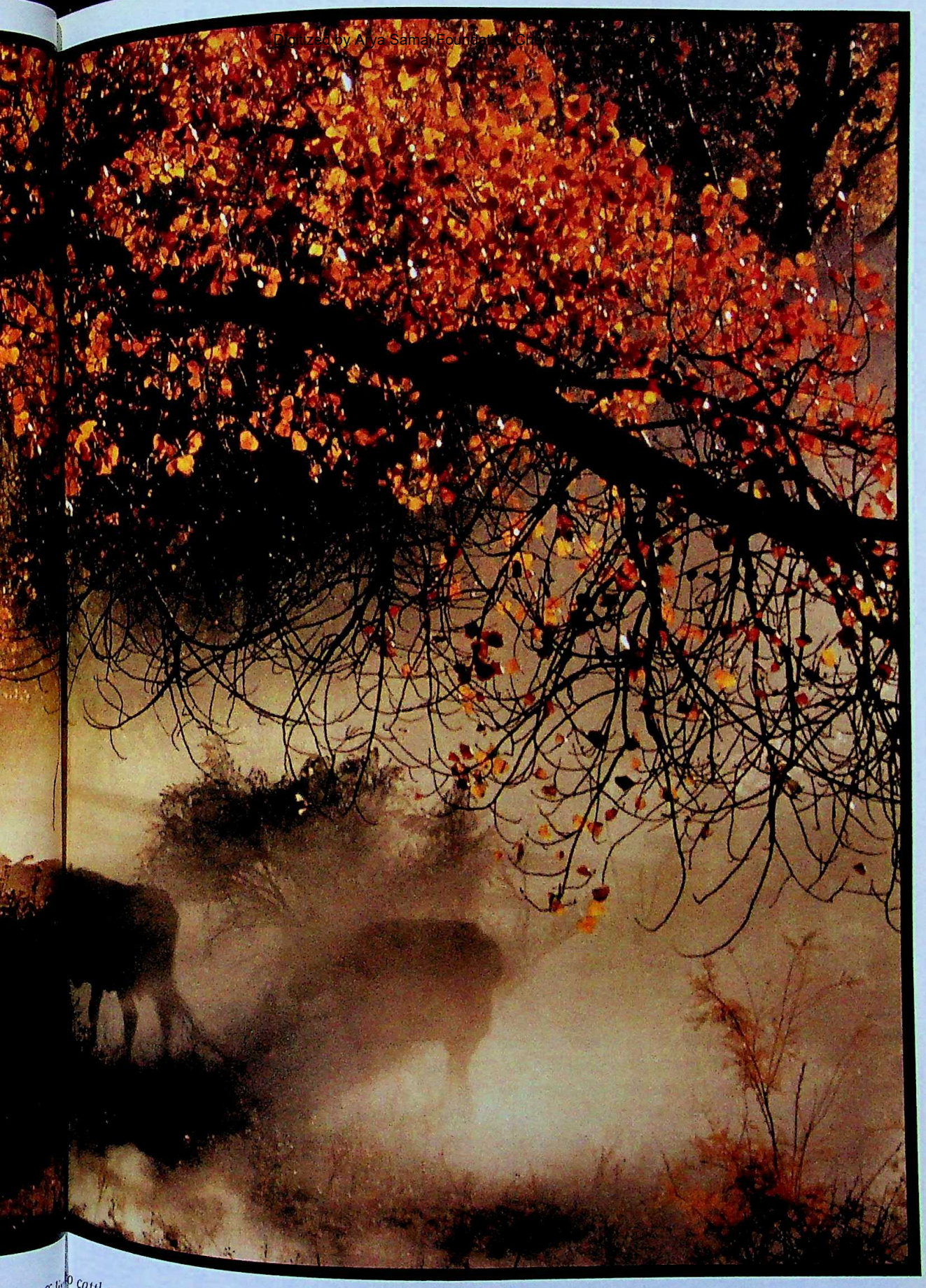

now off-limits to cattlemen. A fifth-generation rancher, LeFevre clings to grazing rights elsewhere in the monument.

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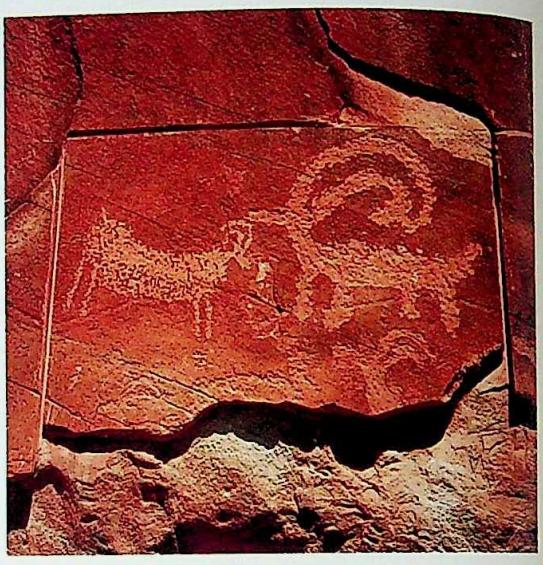
and gas development, and livestock grazing should be allowed where appropriate. Dirt bikers and all-terrain-vehicle riders should be given places to play. "We wouldn't want just a hiker's monument," Liston emphasized.

Wait a minute, said environmentalists. Too many such uses would damage the very land the monument designation is meant to protect. "Grand Staircase–Escalante is one of the largest chunks of basically untouched wild landscape in the lower forty-eight states," argued a SUWA activist I talked with in Salt Lake City. "It was designated to protect wilderness values and should be managed largely as wilderness."

Jerry Meredith, the BLM's monument manager, was the man saddled with reconciling these conflicting visions in his plans. When I talked with him, he had just started, and he said he was determined that every interest get a chance to participate in the planning process on an equal basis. And he was convinced that the process itself ultimately would leach the bitterness out of people. After all the comments and complaints I had been hearing, I was not so sure.



Unkind cuts mark the attempt of thieves to steal a petroglyph of bighorn sheep. The carving dates from about A.D. 900, when peoples of the Fremont and Anasazi cultures shared the area. The monument holds as many as 100,000 archaeological sites, most unsurveyed.

BUT I MAY HAVE BEEN WRONG. About a year and a half after the planning process began, I returned again to Escalante country. The difference in attitudes was little short of astonishing. In the small towns that pock the edges of the monument, there was less talk about lawsuits and confrontation and more about how folks might accept the monument and make the most of it—particularly when town fathers and mothers considered the increase in tourism since the monument was announced. Between 1996 and 1998, annual visitation had risen from 520,000 to 850,000.

"The most common phrase I've heard," Ron Hitchcock, Escalante High School's principal, told me, "is 'We'll make lemonade out of the lemon that's been handed to us.'" Escalante, as it happens, has been making a lot of lemonade since the spring of 1997. There is, for example, the Escalante Center, a complex of educational facilities planned for 28 acres of land next to the high school. The BLM is planning to build a visitor center here, and the Escalante Center itself will feature research and educational efforts based on the monument. Ron is chairman of the center's board. "If our high school is, in many ways, the cultural center of Escalante, as so many small-town high schools are," he said, "then having a true Escalante Center next door can only enhance that role. The entire community, county, and area can take pride in it."

His wife, Sandie, agreed that the monument may eventually become a force for unity. When she was mayor of the city in 1998, she worked hard to overcome the locals' resentment of the monument and their distrust of the federal government and the environmental community. She was particularly proud, she said, of her work in getting local officials and environmentalists from SUWA, Great Old Broads for Wilderness, the Grand Canyon Trust, and other organizations

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to sit down together, talk over their differences, and begin, however slowly, a process of mutual understanding.

"I have to give a lot of credit to members of the city council who were willing to sit down and open up their minds to the 'enemy,'" Sandie Hitchcock said. "And SUWA, for example, has demonstrated that it's willing to work with our community to resolve problems." Not long ago, such communication would have been nearly unthinkable.

While not everyone, whether hard-line environmentalist or wilderness-resistant local, has unqualified praise for the Escalante Center, most seem to be willing to give the effort a chance. And most will give Kate Cannon, the monument's associate manager, the benefit of the doubt too. Cannon gave me a quick tour of the BLM planning office in Cedar City. I asked her if the planning team had encountered major pressure to pave roads and otherwise develop the monument. "No," she said. "That's been one of the interesting surprises. One of the things we heard loud and clear from all constituencies was 'Leave it alone. Keep it remote, keep it rough, keep it difficult to access.' And that's what we intend to do."

So how did she think people were going to react when they saw the plan's first draft? She flashed a wry grin. "They're going to *love* it."

AMAZINGLY ENOUGH, while they didn't necessarily love it, many at least liked much of it. The draft plan was released last November 16, and, just as Cannon had promised, its "preferred alternative" was long on wildness and short on development.

The emphasis throughout was on the natural and scientific values of the monument. More than a million acres would be managed as "primitive" zones, with access and use restricted to preserve their wilderness characteristics. Another half million acres would be managed as "outback," with their own, less rigid restrictions. There would be no new paved roads in the monument, no RV hookups, no big parking lots, no concessions. Seventeen streams would be recommended for designation as wild and scenic rivers. All tourist and administrative facilities would be built in surrounding communities, giving each town an economic stake in the monument's preservation—and going a long way toward diluting old angers.

The plan did meet with mixed feelings from some quarters. "I'm concerned," Louise Liston told me, "that it's clearly slanted toward preservation, and I worry that some historic uses of the land will be restricted." At the same time, she said, she favored the emphasis on the educational and scientific importance of the monument and very much liked the Escalante Center idea.

So did Mike Matz, executive director of SUWA, even though his organization and other wilderness advocates would still have liked to see most of the outback zones managed as wilderness, as the primitive zones would be, until such time as they might be folded into the National Wilderness Preservation System. He was not happy with the 591 miles of routes the BLM had set aside for the use of all-terrain vehicles or with a number of other points with which SUWA will be taking issue. Nevertheless, he found the draft plan "a whole lot better than we might have expected."

The final plan will be issued in the fall. There will doubtless be changes, good and bad, and the final result is not likely to satisfy everyone. Such plans never do. Still, I smell a species of hope here.

I remember the kind of development that has brought so many paved roads, parking lots, crowds, commercialism, and urban excess to Yosemite, Grand Canyon, Zion, and many other national parks that their managers must now spend much of their time trying to turn back history. By embracing and protecting most of the wildness that defines and sustains this newest American monument, the BLM—often ridiculed as the "Bureau of Livestock and Mining"—might just get it nearly right from the beginning. Are you watching, Everett Ruess?

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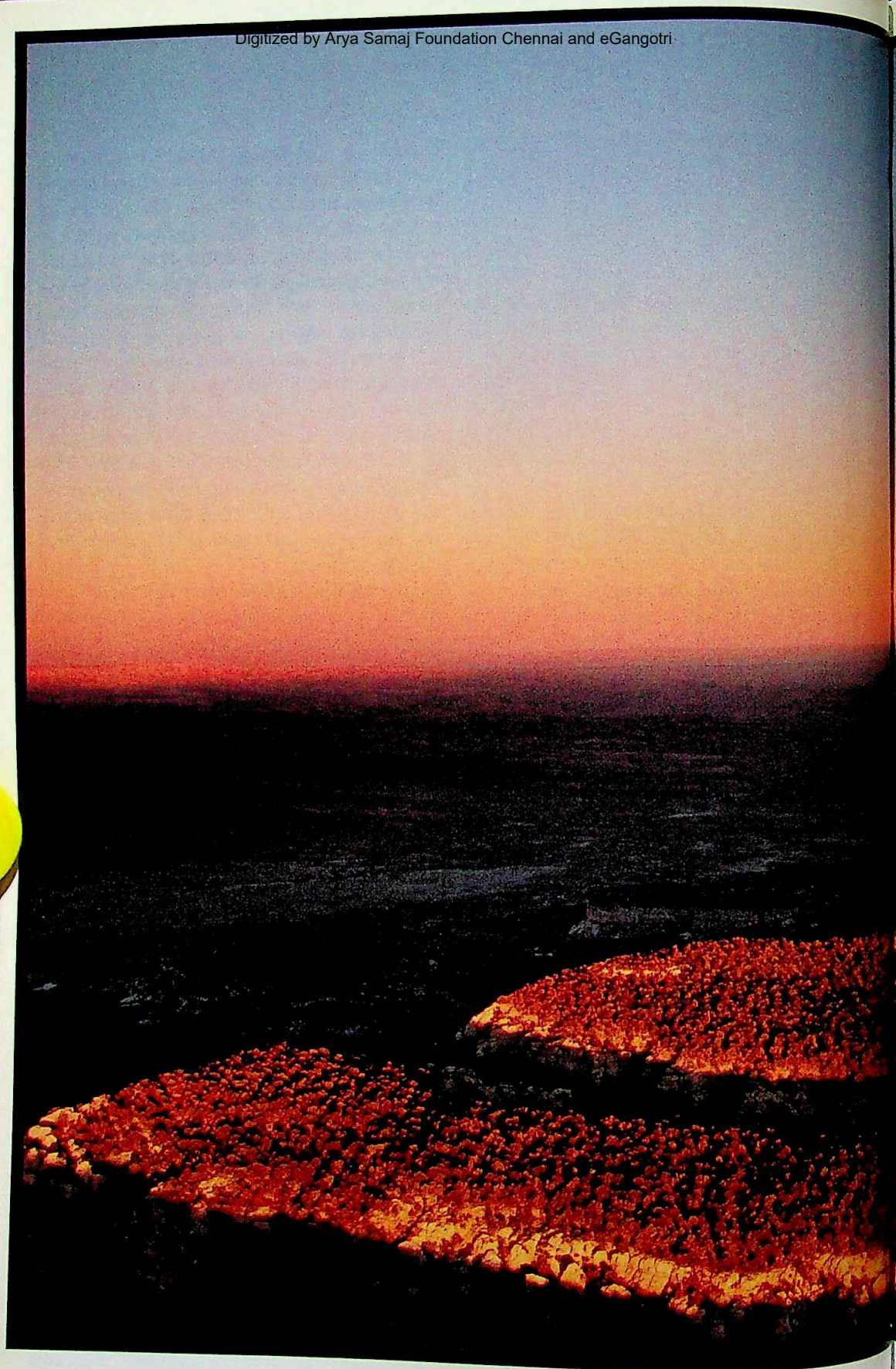

No-man's land: That's what locals call this gaunt, mineral-rich slice of the Kaiparowits Plate Monum

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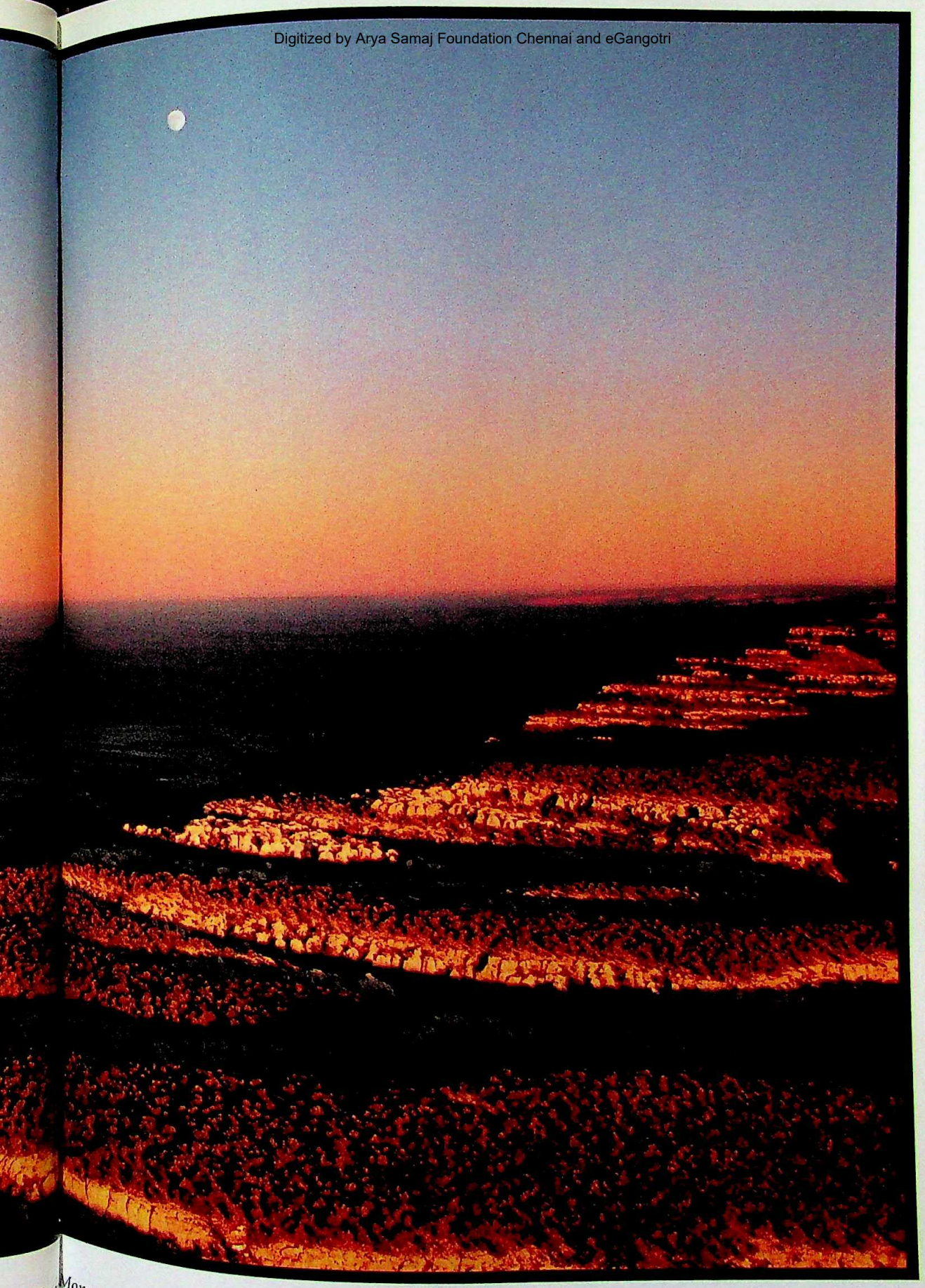

wits Plate Monument status will likely stymie plans for coal mining. For this outback, wilderness is wealth enough.

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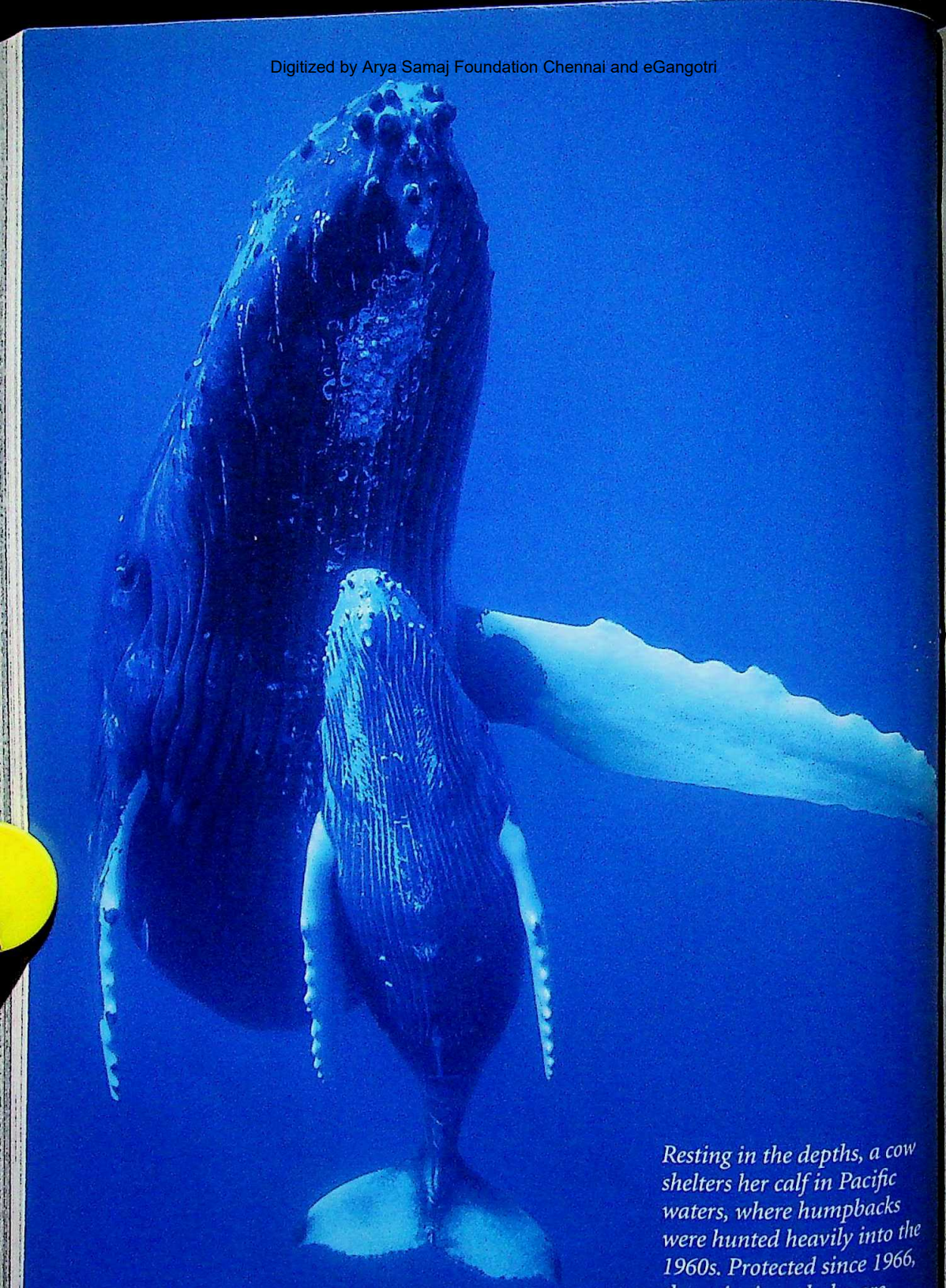

Resting in the depths, a cow shelters her calf in Pacific waters, where humpbacks were hunted heavily into the 1960s. Protected since 1966, these singing whales are making a comeback, giving scientists another chance to study individuals like this inquisitive male (facing page) and to fathom the behavior of a still mysterious species.

FLIP NICKLIN, MINDEN PICTURES

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By DOUGLAS H. CHADWICK Photographs by FLIP NICKLIN

LISTENING TO HUMPBACKS

WHEN A BIG WHALE DIVES, currents set in motion by the passage of so many tons of flesh come eddying back up in a column that smooths the restless surface of the sea. Naturalists call this lingering spool of glassy water the whale's footprint. Out between the Hawaiian islands of Maui and Lanai, Jim Darling nosed his small boat into a fresh swirl. The whale that had left it was visible 40 feet below, suspended head down in pure blueness with its 15-foot-long arms, or flippers, flared out to either side like wings.

"That's the posture humpbacks most often assume when they sing," Darling said.

A hydrophone dangling under the boat picked up the animal's voice and fed it into a tape recorder. We could listen in with headphones but hardly needed them. The music was reverberating through the hull and rising from the waves. Bass rumbles that could have issued from the lowest octave of a cathedral pipe organ gave way to plaintive moans and then to glissandos like air squealing out of a balloon when you stretch the neck taut.

With the notes building into phrases and the phrases into repeated themes, the song may be the longest—up to 30 minutes—and the most complex in the animal kingdom. All the humpbacks in a given region sing the same song, which is constantly evolving. Experts have analyzed the frequencies, rhythms, and harmonics and the way themes change

DOUGLAS H. CHADWICK and FLIP NICKLIN, both frequent contributors to NATIONAL GEOGRAPHIC, also teamed up for our August 1998 article on bottlenose whales.

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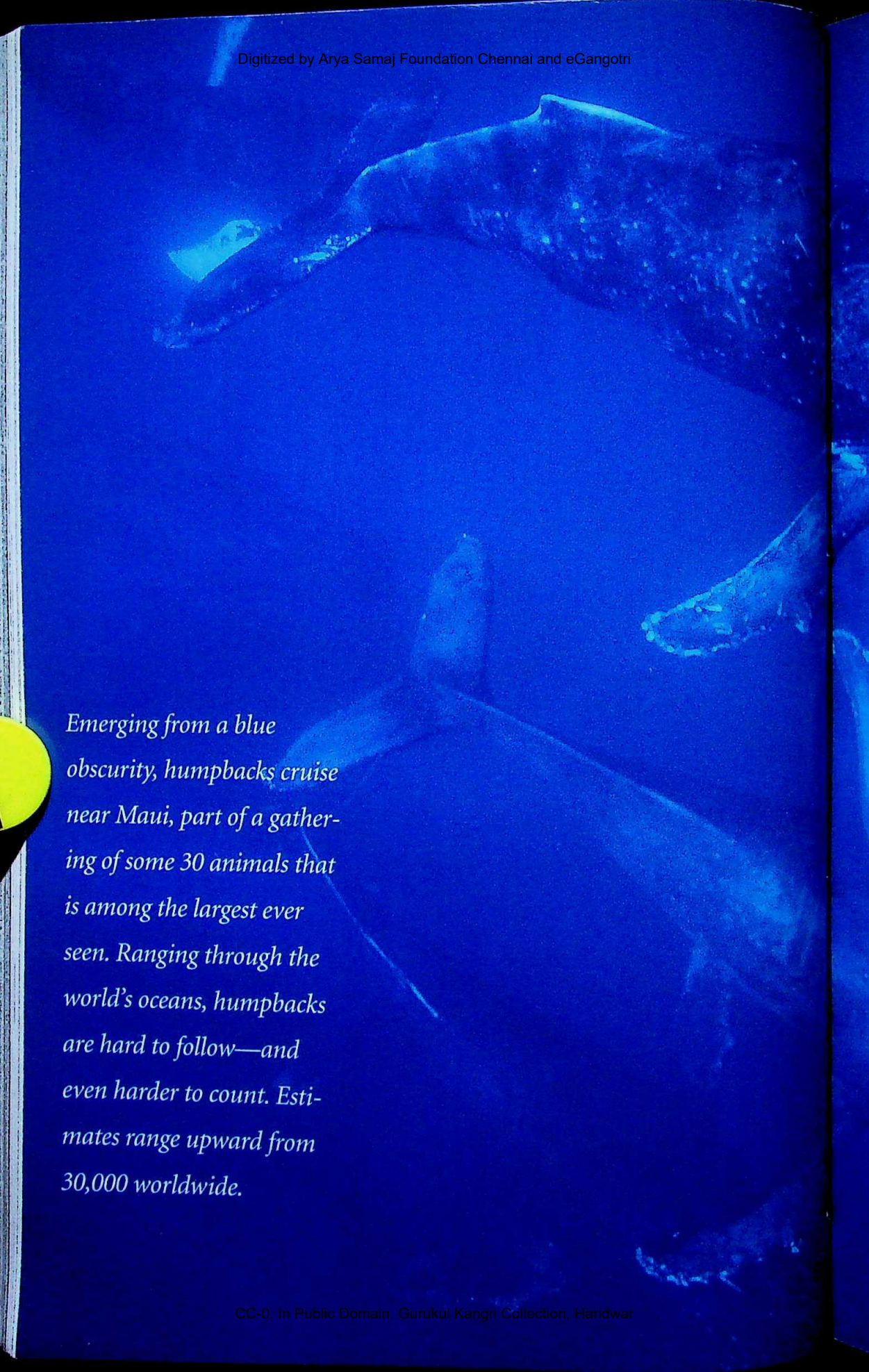

Emerging from a blue obscurity, humpbacks cruise near Maui, part of a gathering of some 30 animals that is among the largest ever seen. Ranging through the world's oceans, humpbacks are hard to follow—and even harder to count. Estimates range upward from 30,000 worldwide.

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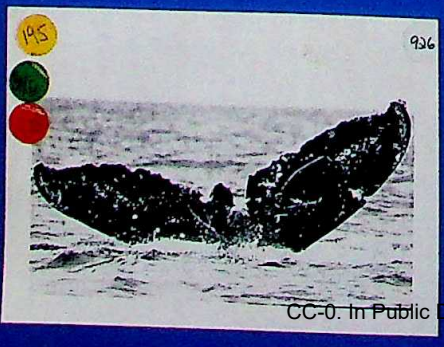

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from year to year and vary from one population to the next. Yet no one really understands what these intricate arias are about.

We do know that humpbacks are found in every ocean. Together with blue, fin, sei, Bryde's, and minke whales, they belong to the rorqual family of baleen whales. Fully grown females, which are bulkier than the males, can weigh 40 tons and reach lengths of 50 feet. Humpbacks tend to favor shallow areas, often quite close to shore, and they are among the most sociable of the great whales and the most active at the surface, all of which makes them among the easiest to observe. As a result, we know more about them than about any other large whale. But we still don't know a lot.

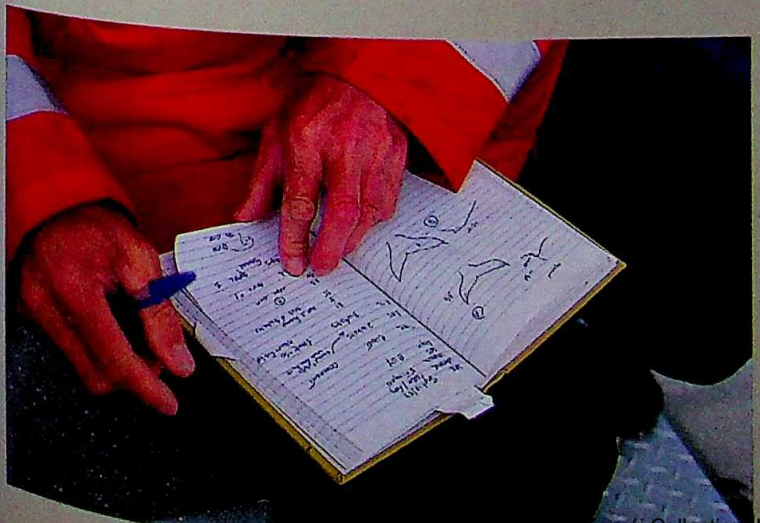
One thing that experts are certain of is that this species, depleted by whaling and not protected throughout its range until 1966, is showing signs of a comeback. Early population estimates are unreliable, and recent ones are hard to get, but numbers in the North Atlantic seem to have rebounded from a few thousand to between 10,000 and 12,000. The North Pacific population was thought to have tumbled from 15,000 to fewer than 2,000. That group stands at 5,000 to 8,000 today.

Knowing I was eager to absorb what biologists have been discovering about humpbacks and their ongoing recovery, Darling, director of the West Coast Whale Research Foundation in Vancouver, British Columbia, brought me along to Hawaii.

Since the singer beneath the boat didn't seem bothered by our company, Darling asked his longtime research partner, photographer Flip Nicklin, one of often serves as Darling's eyes underwater, to slip overboard. I followed.

Bubbling scuba gear sometimes agitates humpbacks, so Flip and I took only masks, fins, and deep breaths. Suddenly, I no longer heard the whale's voice in my ears. I felt it inside my head and bones. The farther down I dived, the deeper the song seemed to penetrate and the more singers I became aware of in the distance, as the sounds carry for miles at depth. At 30 feet I was totally immersed—dunked, drenched—in humpback music. The sea quivered with it and with javelins of light that seemed to converge upon the singer's dark immensity. Surfacing to breathe, I noticed the leviathan roll slightly to peer up at me. Next I was treading water in helpless wonder while it came swimming my way.

I dived again, and 40 feet of solid whale passed so close that I could have reached out and touched its eye. Then the creature turned. And then it came directly at me. At the last instant it braked with its flippers. We were left hovering nose to nose. The moment probably called for profound thoughts, but I couldn't have told you my name. Slowly the animal tilted upward, bringing its head above water. I did the same and found myself staring up at a wall of quivering white throat with clusters of barnacles on the chin. The whale spiraled down toward the hydrophone and looked that over as if considering crooning into it, circled to take in the boat propeller, sank tail first to rest vertically just under the craft, which appeared dinky by comparison, and finally continued down, spread its arms, and resumed singing.



Showing his ID as he floats head down in the singing position, Frank (facing page) displays the unique pattern of tail markings that marine biologist Jim Darling photographed in 1979 (inset) and now uses to recognize him. Sketches (left) keyed to his collection of photographs have helped Darling track individual humpbacks since the late 1970s. Earlier research was based on animals killed by whalers or onetime sightings of live whales.

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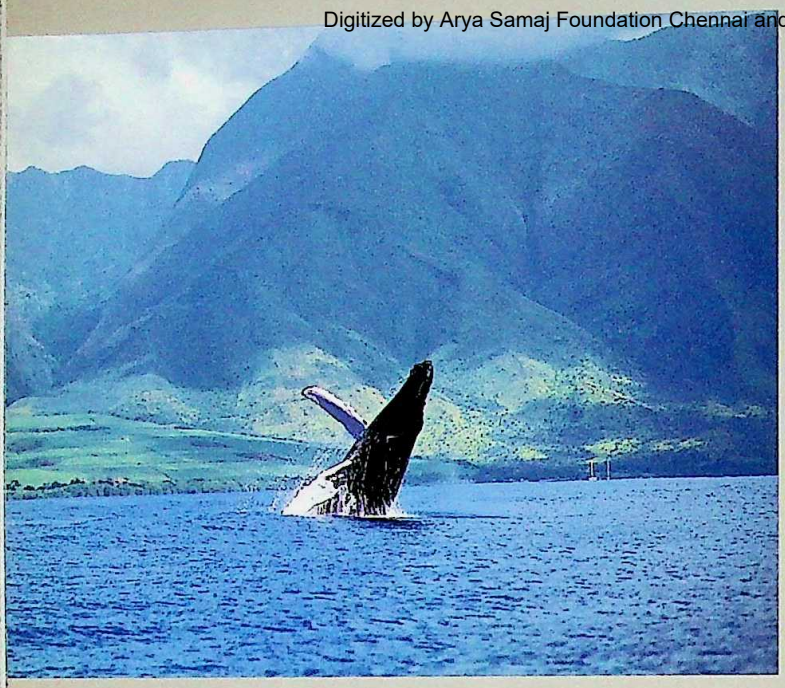
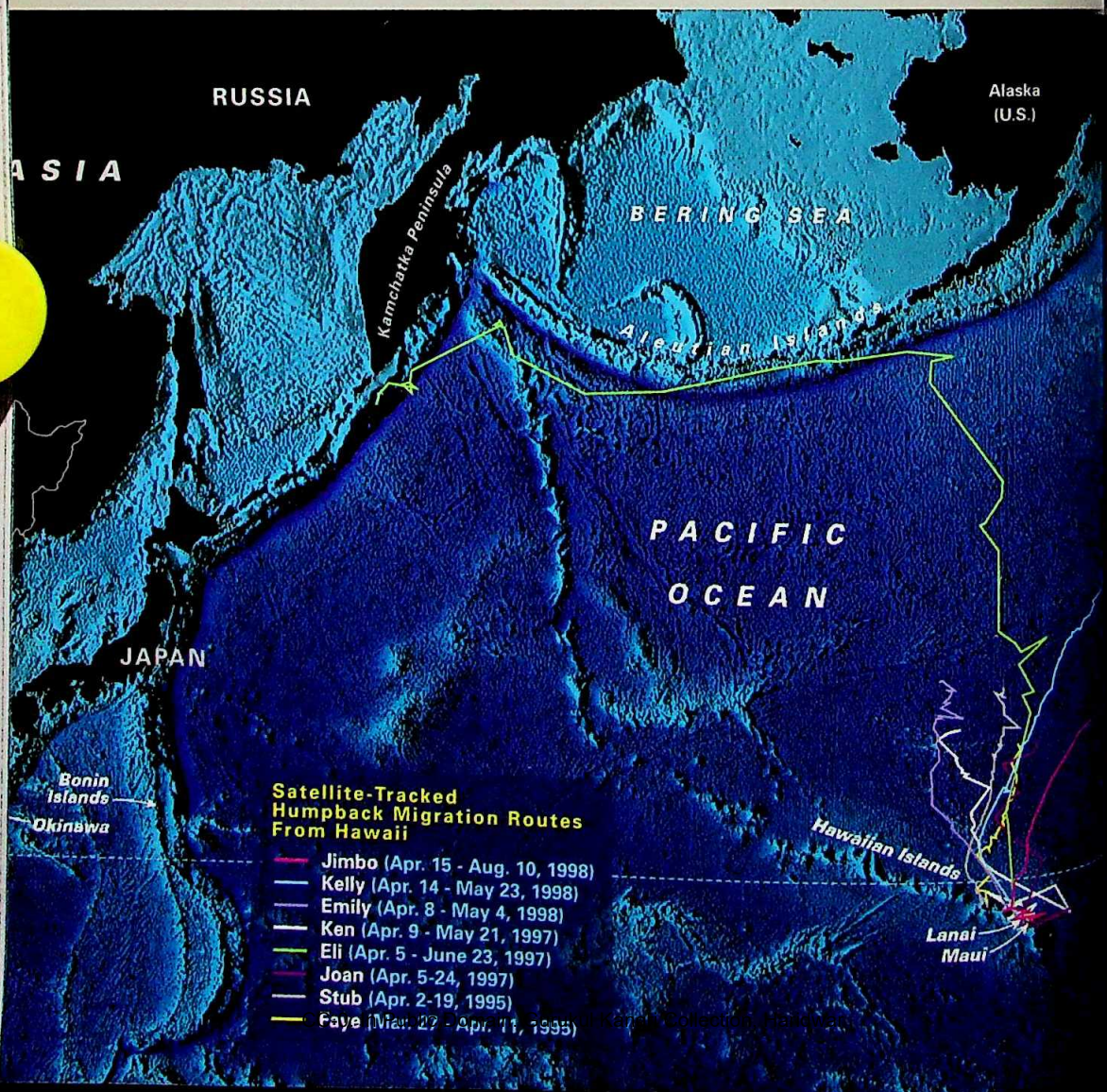


From winter breeding grounds in Hawaii, where a whale breaches (left), humpbacks disperse each spring to feeding areas across the North Pacific. They normally swim at a steady 3.5 miles an hour, says Bruce Mate of Oregon State University, who tagged whales with radio transmitters and charted them via satellite (map, below). Previously scientists knew only that some humpback whales journeyed to the northeastern Pacific to feed. Mate's research shows humpbacks to be intrepid travelers, cruising as far as 5,000 miles from Hawaii to Kamchatka.



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DARLING WAS THERE trying to puzzle out the role of the song, heard primarily during the breeding period. Whales belonging to the dozen or so populations of humpbacks follow different migratory routes between high latitude summer feeding ranges and warmer wintering sites, where the giants essentially stop eating and concentrate on mating, birth, and the rearing of young. Hawaii is a breeding area for North Pacific humpbacks, which start arriving in November and leave by April. Darling had already established that the singers are males. Most people assumed that the animals, like male songbirds, sing to attract mates. He wasn't so sure and wanted a more thorough look.

Minutes after my face-to-face meeting with the whale beneath our boat, another humpback loomed into view, presumably drawn by the song. The singer went silent as the newcomer, known as a "joiner," approached, and they began swimming rapidly around each other. When they surfaced, Darling fired a small dart into each to collect tissue for genetic analysis, which is the surest way to tell the look-alike sexes of humpbacks apart and can also reveal whether animals are related. The two whales headed northwest together. Flip and I heaved back aboard, and we set off in pursuit. When the whales raised their tail flukes, Flip took pictures of the undersides, whose distinctive patterns of black-and-white pigments serve to identify individual humpbacks.

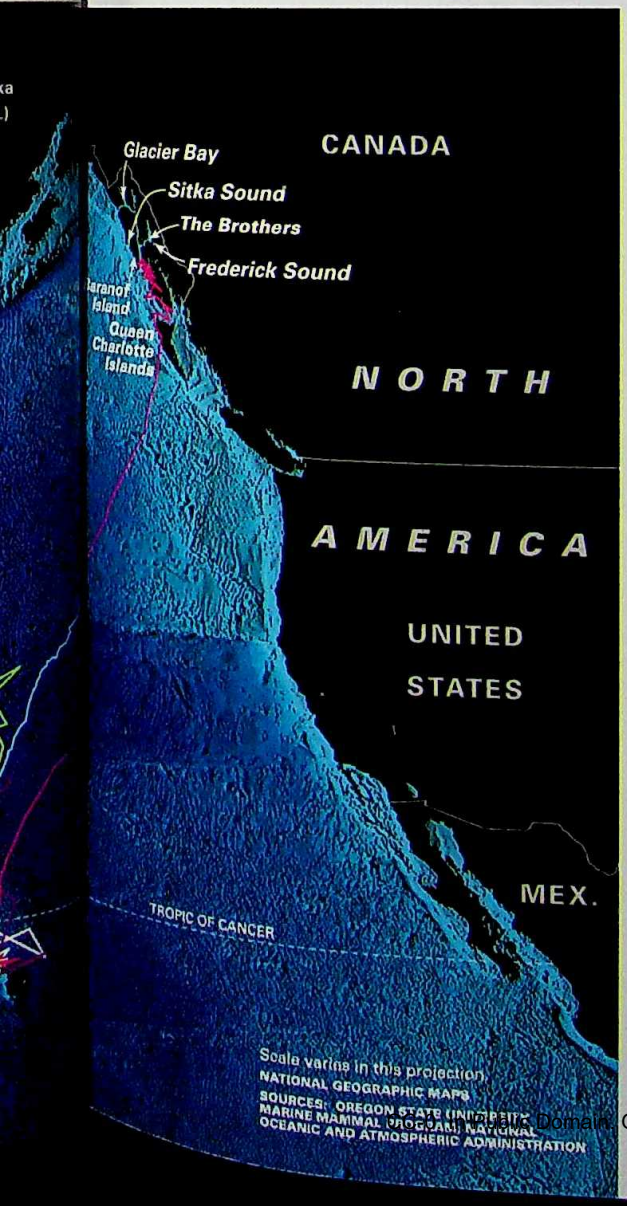
The team was elated. Between rough weather, missed shots, equipment breakdowns, uncooperative animals, and the difficulty of tracking even a tolerant whale long enough to interpret its activities, Darling is lucky to document two dozen encounters between singers and joiners during an entire winter field season. This was the first time a get-together had been witnessed and photographed underwater.

The tissue sample later revealed that the joiner was a male. Samples from earlier encounters showed that most of the joiners were males, not females. What's going on?

An available female, or cow, will generally be accompanied by a male thought to be courting her. Known as the principal escort, he attends her closely and fends off secondary escorts that approach too near. Perhaps the average male sings to recruit other males because his chances of getting close to a female improve when the principal escort is distracted by a number of rivals. A simpler possibility is that the serenade is intended for females but ends up luring challengers. Or, for all its ethereal qualities, the song could just be a version of the old masculine challenge: I'm big and tough and ready to rumble. Darling even wonders if singing could be the acoustic version of carrying around impressive horns or antlers—or wearing expensive wristwatches—as a way for males to advertise their fitness to prospective mates.

"The image of whales as gentle giants or some sort of special, enlightened beings seems to have become quite popular," Darling told me. "But whales are descended from early hoofed animals, and we might understand some of their breeding behavior better by viewing it in the context of a typically competitive mammal society."

In the days to come he would show me



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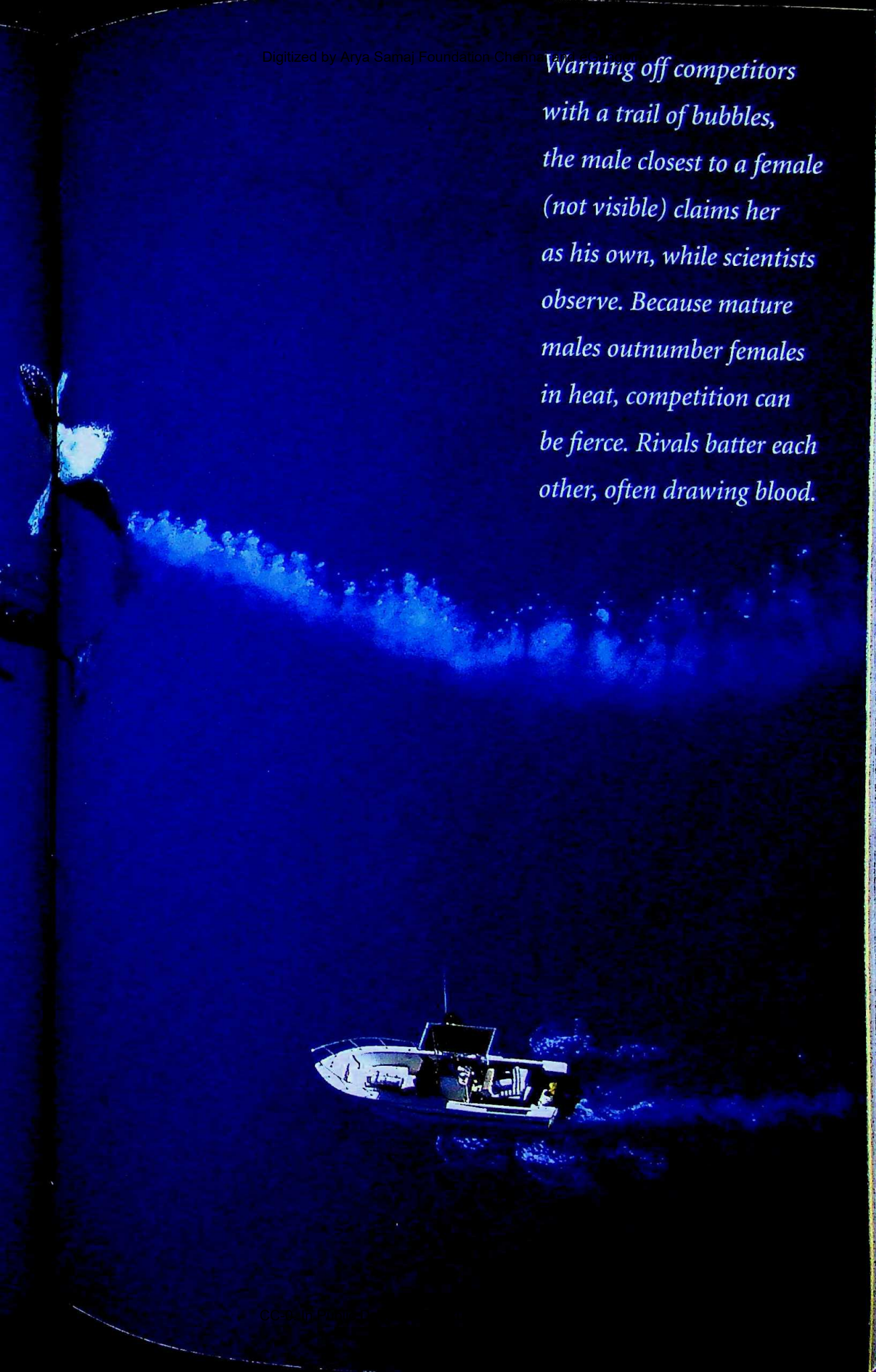

Warning off competitors with a trail of bubbles, the male closest to a female (not visible) claims her as his own, while scientists observe. Because mature males outnumber females in heat, competition can be fierce. Rivals batter each other, often drawing blood.

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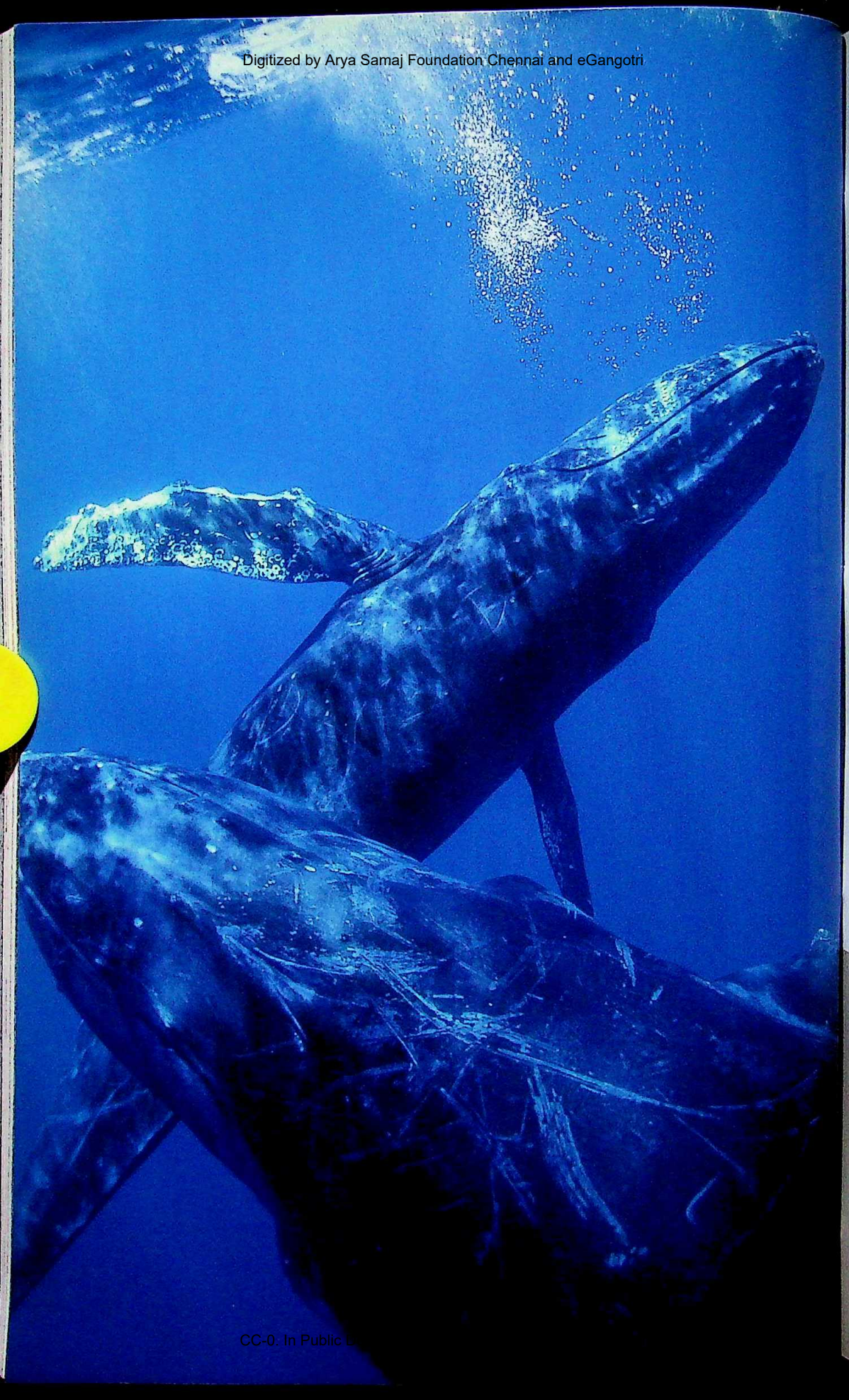

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how males jockeying for position sometimes lunged along the surface with their heads uplifted and gulped water to swell their massive throats in an apparent attempt to make themselves appear larger, like land mammals do by raising hackles and manes. They blasted rivals with disorienting clouds of bubbles, fended them off by extending pectoral fins, and lashed at one another with tail flukes.

Underwater near a large group of humpbacks I witnessed escorts colliding with one another. I could hear the whams and whumps resound. Many of the animals had bloodied dorsal fins and noses, as the barnacles that humpbacks host can turn a low-level shove into a serious scrape.

EVEN THE HUMPBACK'S more ordinary qualities have a touch of the fantastic about them. The species' common name comes from the hump on the forward part of the dorsal fin and from the way the back flexes upward sharply before a dive. Sometimes a group of humpbacks swimming in single file all arch to go under around the same time. At a distance you would swear you were looking at the rippling coils of a gigantic sea serpent.

"I'm guessing that a few old-time tales got started that way," said Steve Zeff, a naturalist guide on the *Maui Nui Explorer,* a tourist boat out of Maui's port of Lahaina with a morning load of whale-watchers. Humpbacks were high-jumping everywhere, trailing waterfalls and twisting in midair to land on their backs in geysers of spray. Their often white flippers, the longest of any whale, earned the species the genus name *Megaptera,* or "great-winged." When one shoots from the sea with bright arms flung wide, it really does seem for a moment that whales can fly.

Rachel Cartwright, who studies humpback females and their offspring in Hawaii, told me she saw a juvenile leap from the water a hundred times in a row. Herman Melville, the author of *Moby Dick,* described humpbacks as "the most gamesome and light-hearted of all the whales." In addition to breaching, these marine athletes will repeatedly slap the surface with their heads, flippers, or flukes. Pounding the water may be a form of communication, like singing. Then again, it could simply be the revved-up result of social hopes and frustrations hidden below the waves.

While we cruised by, visitors all around the islands were whale-pointing from tour boats, beaches, and balcony windows, and cars pulled abruptly off to the sides of highways. Humpback-watching is also big business in Alaska, New England, and parts of Canada, Australia, and the Caribbean. Whale-watching generates perhaps a billion dollars a year worldwide.

The change in human attitudes from the last century could hardly be more dramatic. Then, the growth industry was whaling, dominated by the Yankee fleet. Sperm oil, a prized lubricant, made sperm whales a favorite target, as were slow-moving, easily harpooned bowhead and right whales, hunted for their baleen. As they played out, whalers turned to humpbacks, which yielded a less valuable oil. In 1966 the International Whaling Commission at last

Crooning to a distant audience, a humpback (right) sings into a hydrophone. Scientists are unsure why males perform such songs during breeding season. Some believe they are meant to attract females, but Darling notes that a singer (left, in back) invariably draws male "joiners," such as the scarred veteran charging into the foreground. "It may be an acoustic display," he says, "serving the same purpose as horns or antlers."

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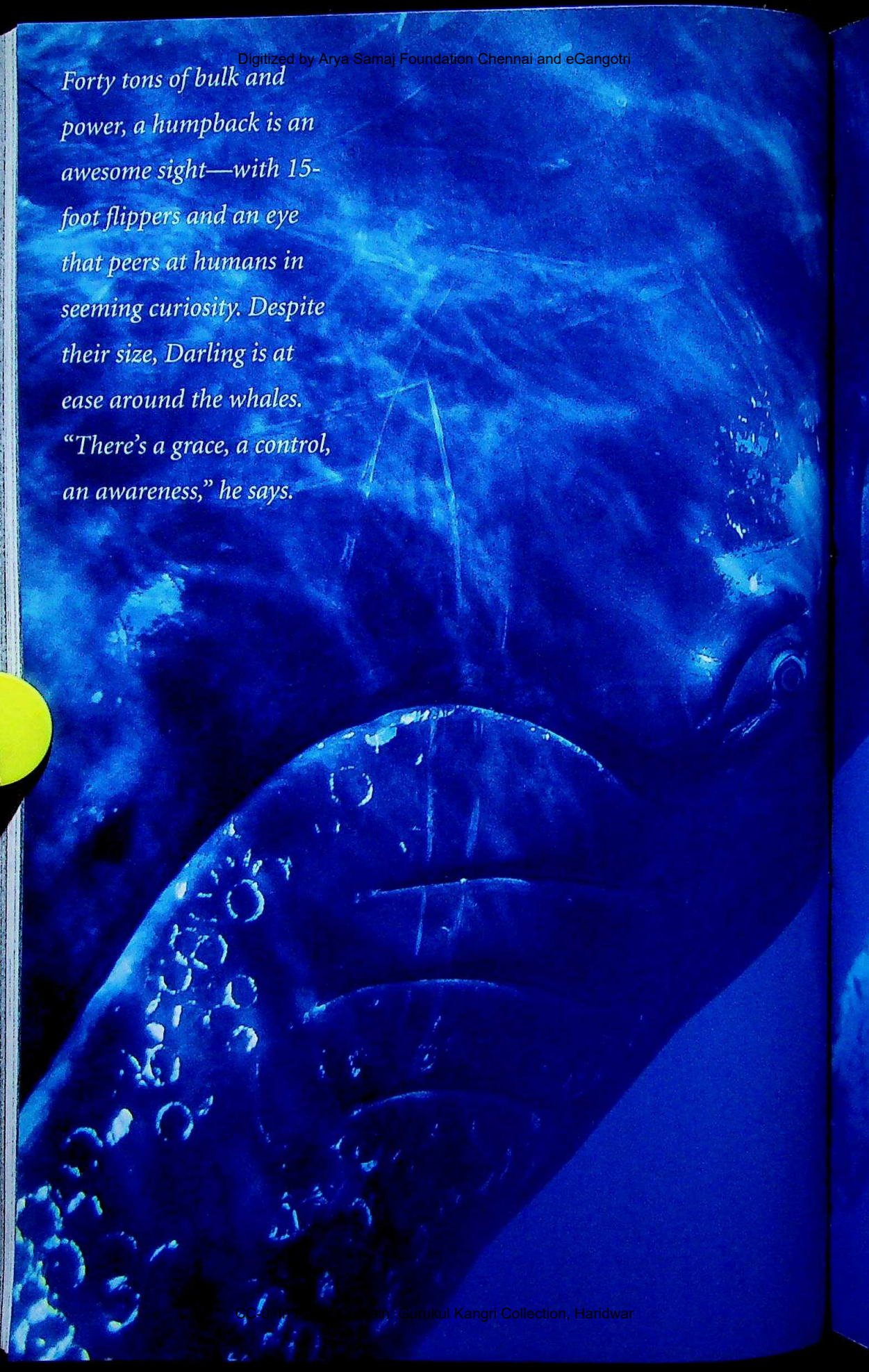

Forty tons of bulk and power, a humpback is an awesome sight—with 15-foot flippers and an eye that peers at humans in seeming curiosity. Despite their size, Darling is at ease around the whales. "There's a grace, a control, an awareness," he says.

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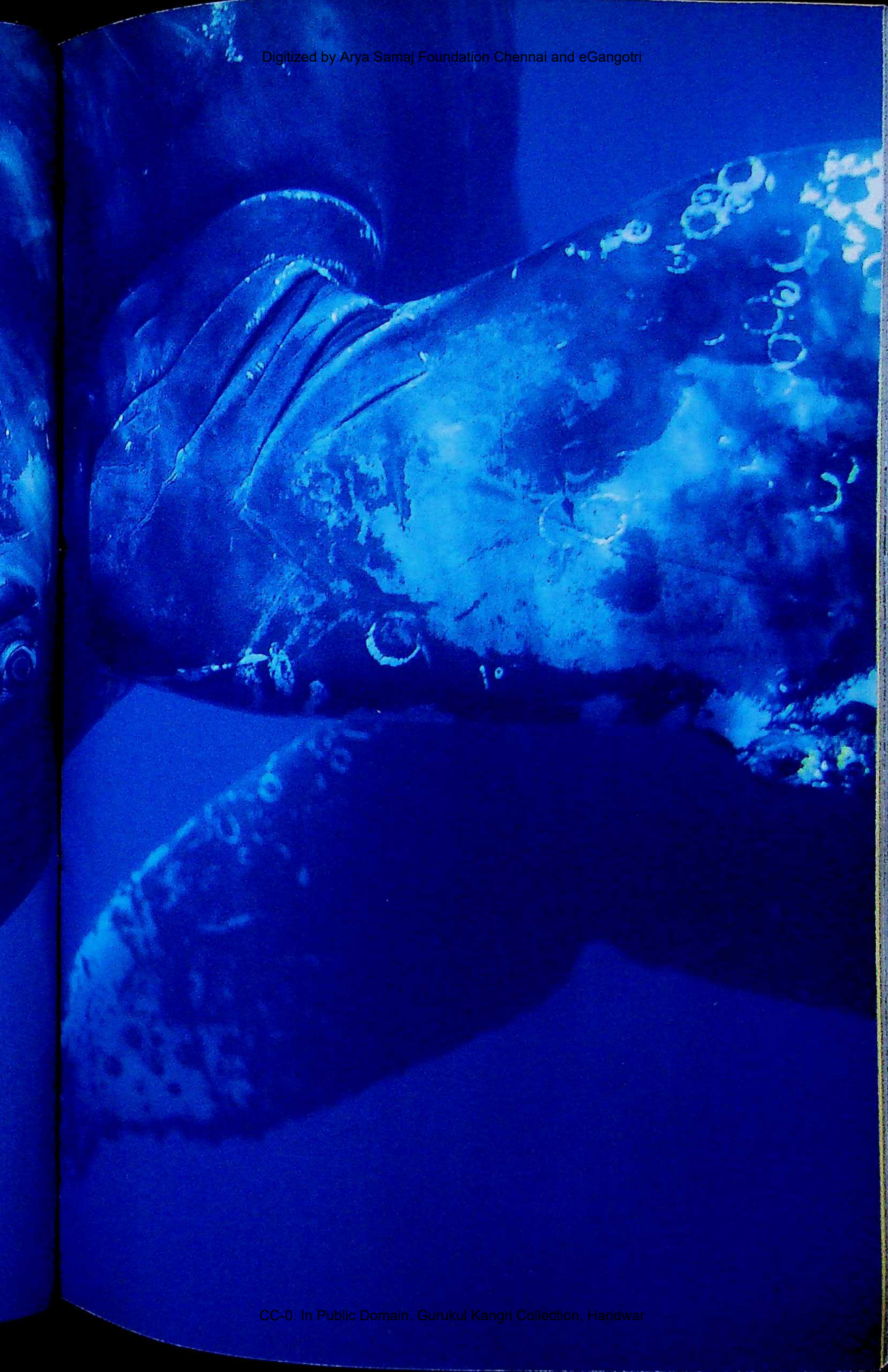

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Hunting for knowledge, Darling takes aim at a humpback trolling for fish off southeastern Alaska (left). The dart he fires bounces off the whale's back barely noticed (right) and is retrieved, carrying a tiny core of fat and skin on its tip (far right). Genetic tests on such samples can reveal the sex and bloodlines of individual whales. Using this method, Darling is trying to establish the ratio of males to females at these feeding grounds.

banned commercial killing. By then the worldwide population of humpbacks, estimated to have once stood at 125,000 or more, may have been reduced by as much as 95 percent.

Southern humpbacks took the hardest hit. With distinctively white undersides flashing through the depths, they feed in rich Antarctic waters through the austral summer, migrate to breeding grounds as far north as the Equator, and until recently were not known to mix with northern humpbacks. Which is why marine biologists were increasingly worried as the years went by and the southern group showed few signs of recovery. No one understood the cause until 1994, when data from Soviet factory ships revealed that Antarctic humpbacks by the tens of thousands had been killed between 1949 and 1972. Lately, sightings in some southern areas have been rising close to 10 percent annually.

At least 3,000 to 3,500 humpbacks—perhaps half of the North Pacific population—breed in Hawaiian waters and are thought to forage through the warm months off British Columbia and Alaska. Another subpopulation feeds off Washington, Oregon, and California and winters by Mexican shores. A third North Pacific group, once common along Asia's continental shelf, was taken out by whaling. Or so authorities thought before survivors were documented by Jim Darling and his colleagues during the 1980s. More than 500 now migrate from northern regions to Japan's Bonin Islands and Okinawa, where humpback-watching tours are a growing enterprise.

IN HAWAII hope was rising before my eyes in the form of new, light gray babies. "The first time I went in the water with a humpback mother and calf, I knew what I wanted to do with my life," said Debbie Glockner-Ferrari. Twenty-four whale breeding seasons later, she and her husband, Mark Ferrari, were still conducting research on humpback mothers and young out of Maui.

We watched several pairs at rest 40 to 60 feet down. Clouds of small fish hovered over the females' broad backs as if they were warm-blooded reefs, scavenging bits of shed skin. The little humpie—relatively speaking, since infants average around 12 feet at birth—would usually be tucked under mom's chin or one of her flippers.

Whereas the mother might stay down as long as 45 minutes, babies can't store as much oxygen and frequently surface for fresh air. And if you're anywhere near, many calves can't help coming over for a curious glance or two. Certain mothers are relaxed about it; others quickly rise to herd the youngster away. Sometimes it's the calf that acts shy while the mother is the inquisitive one.

"They are highly individualistic animals," Debbie said. "One of our favorites was Daisy, a wonderful, friendly female and a very important whale scientifically." Daisy showed up with a new baby four years in a row when the textbooks all stated that humpbacks could only produce a healthy calf once every two to three years. In all, the females that Debbie and Mark

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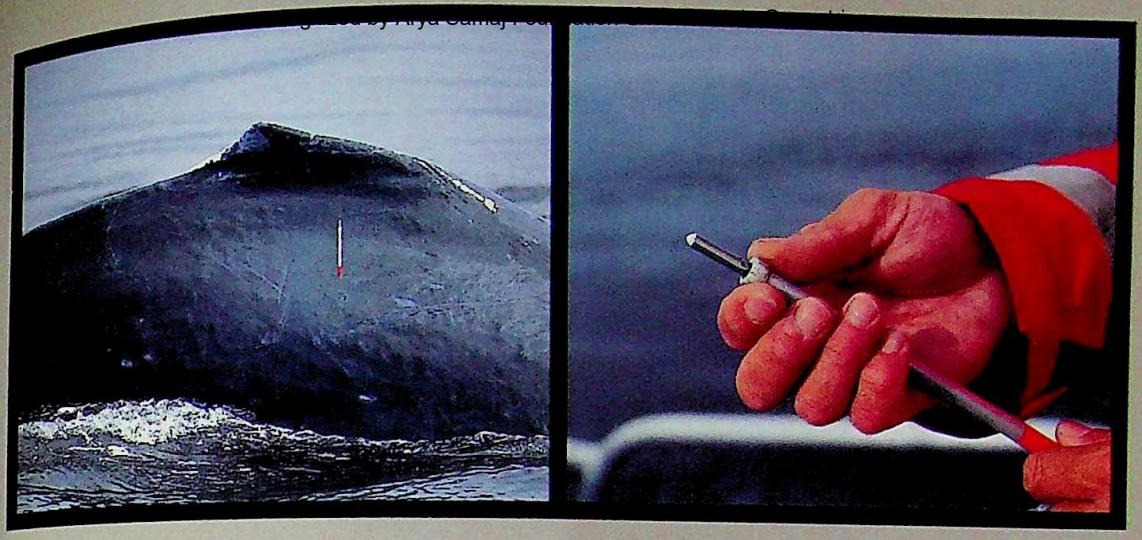

were able to recognize had calves a year apart 16 percent of the time. This discovery suggests that the whales' potential for a strong recovery from their low numbers could be higher than anyone dared wish.

A mother humpback's rearing chores begin immediately upon birth. Because the infant's lungs are not inflated, the baby will tend to sink until its mother nudges it up to the surface for its first, sweet gasp of air. For most of the next year, mothers provide milk, guidance, and protection from enemies. At least a quarter of the females carry rake marks from teeth. Many are caused by killer whales, which attack a variety of baleen whales and focus on vulnerable targets such as the young.

Moby made it through his first year or two in fine fettle. That's the name the researchers gave a stout, pale gray youngster. They introduced me one morning during my second season in Hawaii. Moby spun and frolicked around us for a couple of hours and once nearly landed atop us with a breach. Every so often our 30-ton playmate would break off to rush toward a nearby vessel and nose around the stern, sometimes bumping the hull or slapping it with a fluke as he turned. Whale-watchers call such extra-close encounters muggings.

"One day we saw a female mugging boats," Mark recalled, "and there was an odd pattern to it. She would curve her tail in front of the bow to hold the ship in place and bring her head around so that her eye was close to the propeller. Then we noticed that her calf had a series of deep, healing gashes along its back. You could tell it had been badly cut up by prop blades. Now, maybe it only looked like this mother was inspecting propellers, searching for the guilty boat. But I kept thinking: Man, I don't want to be around when she finds it."

Another time, people watching a courting group realized that one member was no longer surfacing. It was a male, and it had just died. After the other whales left, one male stayed on with the corpse, using its flippers to stroke the body, occasionally trying to lift it up for air. The companion stayed through the afternoon, driving Mark away when he approached in the water. It was still there when darkness fell.

With whales, even interpreting something as ordinary as feeding can be tricky. Lacking teeth, baleen whales gather food by gulping the seawater that contains it. Then they use their tongues to force the liquid out through a sieve of fibrous plates—the baleen—hanging from the roof of the mouth. Since the process is often described as straining seawater, many people have the impression that the great whales swim around through the oceans with their mouths open, filtering plankton. In reality these mammals travel tremendous distances between sites where the right conditions concentrate food—small fish and krill, in the case of humpbacks.

Suppose one locates a milling ball of herring. The whale may lunge at the prey near the

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surface, plow down into their midst, or dive deeper and circle below the fish, blowing a ring of fizzing bubbles to act as a net, then rise up through the center. Sometimes the animal blows different size bubbles depending upon the size of its prey. The lower jaw swings out from the upper jaw to open at a 90-degree angle, or even wider; one to three dozen grooves, or pleats, on the throat expand; and what was a sleek whale becomes a living vat swollen by as many as 15,000 gallons of water churning with fish.

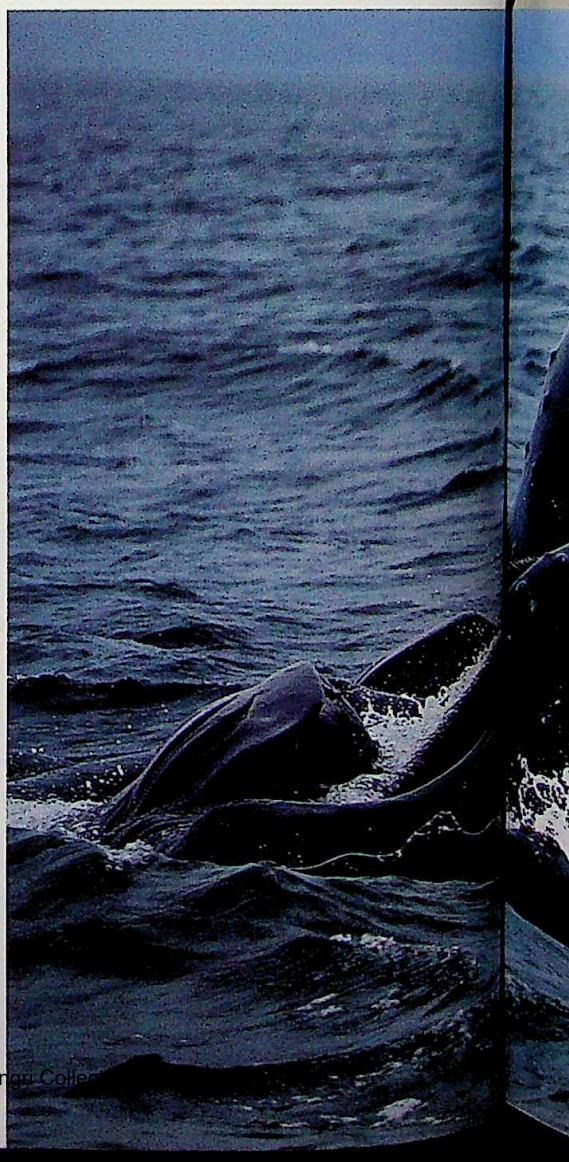
Where the dining is especially rich, humpbacks do all this in coordinated groups of as many as two dozen. As they converge to scoop up the food, they are likely to be screaming—filling the water with prolonged, piercing shrieks that seem designed to further disorient the panicky, trapped targets.

In the North Atlantic humpbacks may thrash their tails as well as lay out huge clouds of bubbles to concentrate fish schools, while around Antarctica the whales' cultural tradition is to slap their flippers to round up prey. Gentle grazers of plankton pastures? Try predators par excellence, carnivores that, depending upon how you interpret bubble netting, may qualify as makers and users of tools.

I joined Darling and Nicklin as they cruised through Alaska's Frederick Sound trying to sort out some of the social relationships within feeding groups. Against a backdrop of rain forests and glaciers, the whiskery heads of sea lions popped up along the tidal rip where several humpbacks had just sounded. Darling lowered his binoculars and said, "When the humpbacks are feeding in a group, they may dive and come up time after time in exactly the same formation. They definitely seem to be synchronizing their movements. The hard part is defining where self-interest ends and true cooperation begins." So far researchers have no evidence that these animals foraging alongside one another are closely related. In fact, the only stable family structure known among humpbacks is the year-long bond between mother and calf. That doesn't mean these whales don't have buddies, colleagues, or whatever you want to call seasonal companions.

We anchored by a group of islands called The Brothers one evening and met up with Fred Sharpe of the Alaska Whale Foundation and his associate Lisa Walker. As we shared a driftwood beach fire, Sharpe said, "We're seeing some of the same individuals together in groups year after year, and researchers up in the Glacier Bay area have found feeding associations lasting two decades. Whales that know each other probably work together more efficiently than strangers can." Cupping an ear, he asked if I had heard a sound out in the darkness. I had. It was a great cry from a humpback.

"Trumpeting like that is associated with a high level of excitement," Walker explained. "We hear it when killer whales are around and the humpbacks are alarmed. But we also hear it when the feeding is especially good, which makes us wonder if they are sending a message for companions to come join them. Underwater they can blast out at 170 decibels—louder than a jet's roar. They also make all kinds of lower intensity social sounds. I wish I knew what they were talking about. What I like



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An eruption of whales churns the surface as five humpbacks (below) snap up herring. Whale-watchers flock to such spectacles (right) during the spring-to-fall feeding season off Alaska, while scientists debate whether groups of whales hunt cooperatively. Among those who believe they do is Fred Sharpe of the Alaska Whale Foundation, who has observed "running buddies" working together to trap fish. Surrounding a school of herring with a net of bubbles, the whales charge open-mouthed to the surface with loud cries, driving the fish before them.

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about humpback research is the way it lets your imagination roam free."

FARTHER WEST I steered Jan Straley's skiff among plumes of spray in Sitka Sound as she shouted, "Turn right! A little more. Steady right there," raising her camera to snap off photographs of whales' flukes for identification. "The lead animal is number 336, a male," she continued, "and the one behind him with the dark flukes is a female, number 206. They've been around here for three weeks, always together. I've known one of them for 15 years, the other for 17." Roving the channels and coves of southeastern Alaska since 1979, Straley, a biologist at the University of Alaska Southeast, has identified around a thousand humpbacks. "I'm starting to see offspring of the offspring of whales that I first knew as calves," she said.

As her records built up, they showed the animals moving up and down the coast of Alaska's Panhandle to visit the same productive haunts year after year. Straley was struck by how late in the season some stayed on: into November, beginning to sing the breeding season song usually heard in the tropics; December, showing aggression typical of courting groups; and January, with snow piling up on the beaches. One old female and one yearling may have stayed through an entire winter.

It is usually said that the humpbacks' foodless tropical sojourn takes up almost half the year, counting travel time. But Straley began to wonder if some Alaska whales, particularly females, might not just shoot over to Hawaii, breed, and shoot back toward the dinner table. This would fit an idea proposed by Darling: Males arrive in Hawaii early and establish a hierarchy, possibly with the help of their songs, that results in the dominant ones breeding a succession of females as they pass through.

Bruce Mate of Oregon State University, a whale expert who leads the way in tracking humpbacks with satellite-monitored radios, found one humpback that covered the 2,600 miles between Hawaii and Alaska in just 30 days. In Maui he invited me to go along with him as he tried to tag more animals with transmitters contained in cigar-size darts. After two weeks of pounding over the waves, he had stiff legs, an aching back, and a fancy crossbow unsprung by salt spray. But he also had several humpbacks in touch with orbiting spacecraft—while having minimized disturbance.

Months later, he said, "One swam directly to the Queen Charlotte Islands off British Columbia, then headed north up the buffet line, hitting feeding sites along the outer coast, until it reached Baranof Island. Then it raced to the Queen Charlottes and back, 400 miles in four days, including stops at all the feeding sites. Almost every time we radio-tag a whale, we find it traveling far more than people imagined."

A humpback that Mate put on the air in 1997 swam due north from Hawaii to the Aleutian Islands, then, instead of heading for the panhandle as expected, it cut west and ended up off Russia's Kamchatka Peninsula before the beacon quit. Looking through collections of fluke photographs, researchers have found the occasional humpback traveling to Hawaii from Japan, Mexico, and southern British Columbia. Straley now and then records whales in Alaska formerly seen summering farther south. The various humpback subpopulations may not be as separate as once thought.

Even as the glad tidings about humpback recovery add up, managers face new concerns that range from underwater sound pollution to competition with the fishing industry. The burgeoning flotillas of whale-watchers can themselves disturb humpbacks, though the rewards in terms of public awareness and education seem to far outweigh any harm from this new version of setting out to sea after whales. Hawaii's officials worry about increasing runoff of silt and chemicals from agriculture and development.

Much of the animals' range around the 50th state lies within the Hawaiian Islands Humpback Whale National Marine Sanctuary, established in 1992 and recently expanded to 1,800 square miles. The Marine Mammal Protection Act fines boaters who go too fast in whale waters or push closer than a hundred yards—unless, as often happens, the humpbacks come to them. Sanctuary rules stiffen those fines and will maintain that level of protection if humpbacks are removed from the endangered species list. Such a move looks increasingly possible. It means we have been doing enough things right to recharge the seas with these sentient giants and the grandeur they impart. I can't remember ever hearing better news above water or below. □

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MILLENNIUM SUPPLEMENT: CULTURE

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NATIONAL GEOGRAPHIC

Global Culture

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OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

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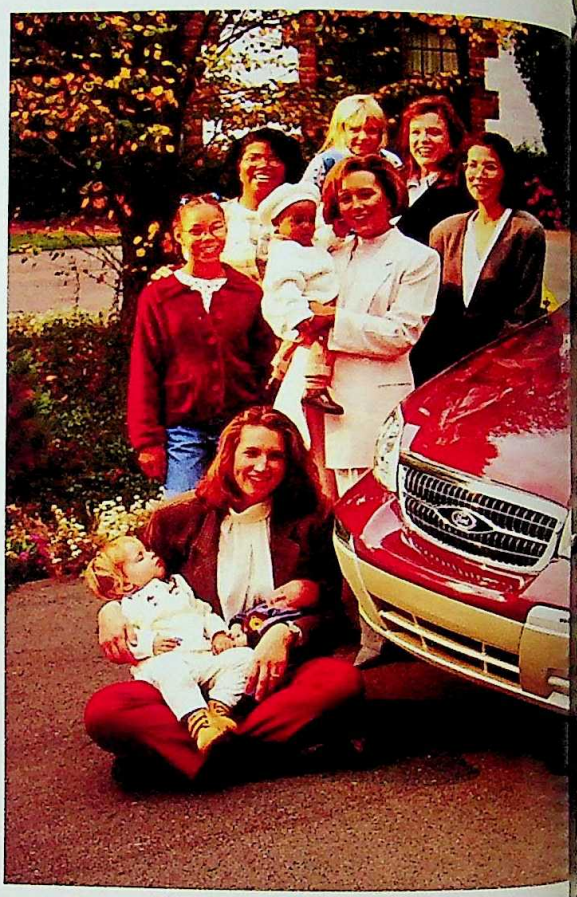
At Ford, we always listen to our mothers.



In fact, 30 of the 1999 Windstar Product Development Team members happen to be moms. Sure, they know torque converters. But they also know diapers, infant seats and juice boxes. And, because they know a thing or two about security blankets, you'll find that Windstar is the only vehicle to earn the government's highest rating – five stars – ★★★★★ in both front- and side-impact crash tests.* And their innovative thinking made Windstar just about as family-friendly as a minivan can be. After all, mother knows best.

*During side-impact crash test, Windstar was equipped with optional side airbags. Always wear your safety belt and secure children in the rear seat.

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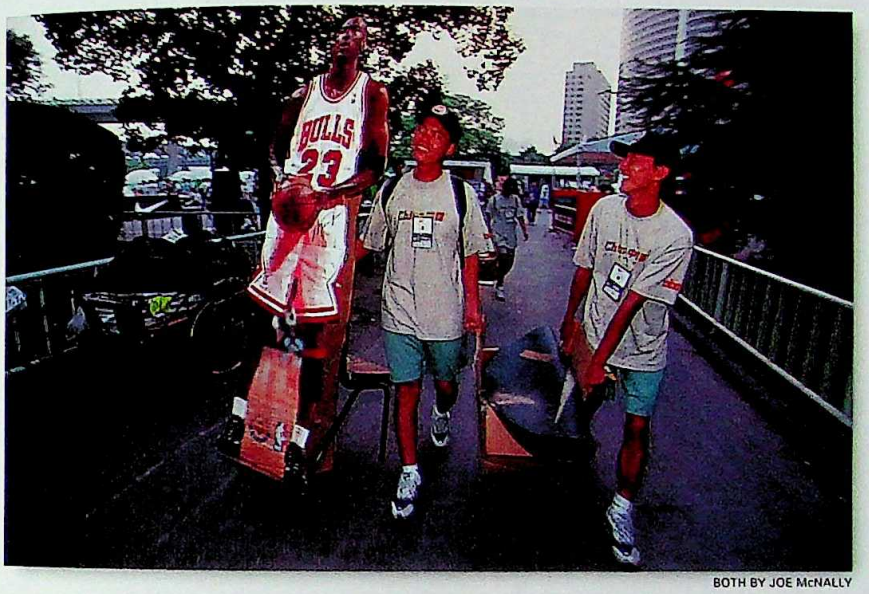
NATIONAL GEOGRAPHIC



BOTH BY JOE McNALLY

From the Editor

"WE HOPE THAT THE WORLD will not narrow into a neighborhood before it has broadened into a brotherhood," Lyndon Baines Johnson said in 1963. The Vietnam-era President spoke before cell phones, before the Internet, before instantaneous global satellite communication, yet his words address both the promises and perils Erla Zwingle explores in this month's story on globalization.

As that term implies, world cultures seem to be becoming homogenized. But for the moment, at least, it is still arresting to see the juxtaposition of different societies, as men in Shanghai proudly carry around a life-size Michael Jordan cutout (above) or a Los Angeles artisan applies Old World henna designs to a woman's hand.

Yes, even NATIONAL GEOGRAPHIC is a part of the phenomenon. We now publish six international editions, and although each has its share of locally produced content, the magazines remain essentially GEOGRAPHIC. In the coming years members reading the English-language edition will enjoy the fine work of our foreign partners as well. As I see it, the world can only benefit from this global give-and-take. In the words of another mid-century U.S. statesman, Adlai E. Stevenson, "Understanding human needs is half the job of meeting them."

Bill Allen

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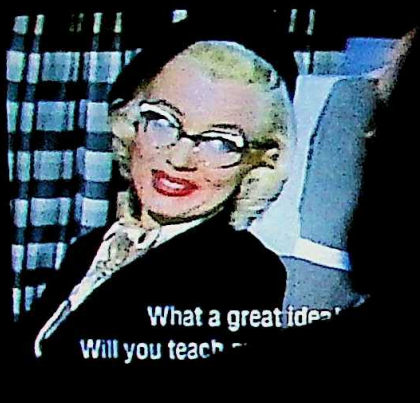

GLOBAL

■ Many Marilyn look-alikes oversee a New York ad agency consultation, while another fa

Monr

By **Joel L. Swerdlow**
ASSISTANT EDITOR

L CULTURE

Monroe (page 75) oversees a jungle—as Western pop seems everywhere to overrun local cultures.

STUART FRANKLIN

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"Cultures are maps of meaning through

AT FREEPORT-MCMORAN COPPER AND GOLD INC.'s 24,700 acres of mines in Irian Jaya, some 14,000 people use huge trucks and excavating machines to hollow out mountains. But what impressed me most when I visited several years ago was fleeting glimpses of local Amungme people who had had little contact with the outside world until Freeport-McMoRan arrived in the 1960s. ■ Some Amungme became miners, mastering new equipment. Others resisted intrusion, using bows and bone-tipped arrows to attack mine workers and buildings. A few sometimes took things from Freeport employees. A boy would grab a pair of knee-high miner's boots and dart away. ■ Why take boots that are of no use unless you work in a mine? The answer: to get manufactured goods. These Amungme saw that outsiders had many novel possessions and wanted their share. ■ As the new millennium approaches, modern technology extends human life spans and levels of comfort. But it also destroys thousands of remote cultures. Today the world's people speak about 6,000 languages, a good measure of diversity; by the year 2100 the number of languages could drop to 3,000, as traditional cultures change. ■ Some of what is lost are brutal practices like ritual warfare and mutilation. But as Wade Davis shows in "Vanishing Cultures," threats to cultures are also threats to unique perspectives on life. Davis spent time with the Penan in Borneo, who have one word for "he," "she," and "it" and six words for "we." What lessons could the Penan teach about social cooperation? ■ Loss of traditional cultures means loss of knowledge too. Many have insights into nature that still defy modern science. Traditional healers, for example, have identified plants that counteract snake venom. ■ The rapid disappearance of remote cultures is part of a larger trend: Human societies have always mixed and changed, but goods, people, and ideas move farther and faster today, spreading an urban-oriented, technology-based culture around the globe in just a few generations. Thanks to radio, television, and videos, this new world culture reaches virtually everyone, even the world's nearly one billion illiterate people. ■ Far from uniform, the new global culture is a shifting mixture of experimentation and innovation in which more and less developed societies learn and benefit from one another. As Erla Zwingle notes in "A World Together," old and

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which the world is made intelligible."

—PETER JACKSON, GEOGRAPHER, 1989

new are mutually transformed. Many changes, such as the growing demand for democracy and human rights, are positive. Others seem less desirable. Chinese culture prides itself on family loyalty, yet migration to cities and changing priorities are blunting age-old traditions like caring for one's parents. ■ Even those who try to protect traditional practices find themselves embracing new technology. Afghanistan's Taliban, who seized power in 1996 and fulfilled their promise to exclude movies and other cultural intrusions, recently completed an old-fashioned stoning by having a tank knock a brick wall down on top of the condemned. ■ As their influence increases, dominant cultures tend to splinter. Sanskrit prevailed in South Asia for centuries, but by 1200, largely because of invasions and the emergence of new religions, distinct groups speaking Panjabi, Hindi, and Bengali had evolved. ■ English, now spoken by more than one-fifth of the world, is an essential element of the new global culture. Are electronics spreading that culture so quickly and pervasively that it will kill any new languages that might take the place of English? Perhaps. But the use of new spoken Englishes is on the rise, as David Crystal points out in his 1997 book, *English as a Global Language.* Ghana, Nigeria, and Singapore, for example, are developing versions of English unintelligible to outsiders. Singapore's Singlish combines English with Malay and a Chinese language called Hokkien. "That's really very sayang lah" has no direct translation but conveys great sadness, a feeling of "what a waste or pity." ■ The city-state of Singapore itself, which has grown from fewer than 300,000 people in 1900 to four million today, also represents a dramatic characteristic of the global culture. Today nearly half of us live in cities. In 1900 only a tenth of us did. The chief reason: technological innovations that require fewer and fewer farmers. ■ Urban life, which seems to have begun in the Tigris and Euphrates Valleys at least 6,000 years ago, is one of the world's oldest inventions. People living in cities generate most knowledge and art, and muster the resources needed to explore what lies beyond humanity's reach or understanding. ■ "Tale of Three Cities" examines leading cities in the years A.D. 1, 1000, and 2000. These cities teach a familiar lesson: Humans can resist and shape change, but, as in nature, loss of the old is inevitable because it makes room for the new. □

The millennium series will continue with articles on science in the October 1999 issue. For more on the millennium visit www.nationalgeographic.com.

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Sublimely at ease in midair, Malaysian-born "action goddess" Michelle Yeoh is just as comfortable with an acting career that routinely hops continents. Linked by jets, e-mail, cell phones, and films, "we are all," says British sociologist Mike Featherstone, "in each other's backyard."

A World

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dTogether

CULTURE CHORUS Gleefully ready to swell an operatic procession, Chinese acrobats costumed as ancient Egyptian soldiers flash smiles and muscles backstage at the Shanghai Grand Theatre. With Italian singers from the Teatro Comunale di Firenze, they performed

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acrobats
Shanghai
formed

in the new opera house's first international coproduction, Verdi's *Aïda*. The 1998 schedule also packed in appearances by Russia's Kirov Orchestra and the Radio Symphony of Berlin, plus a Russian National Ballet production of Tchaikovsky's *Nutcracker*.

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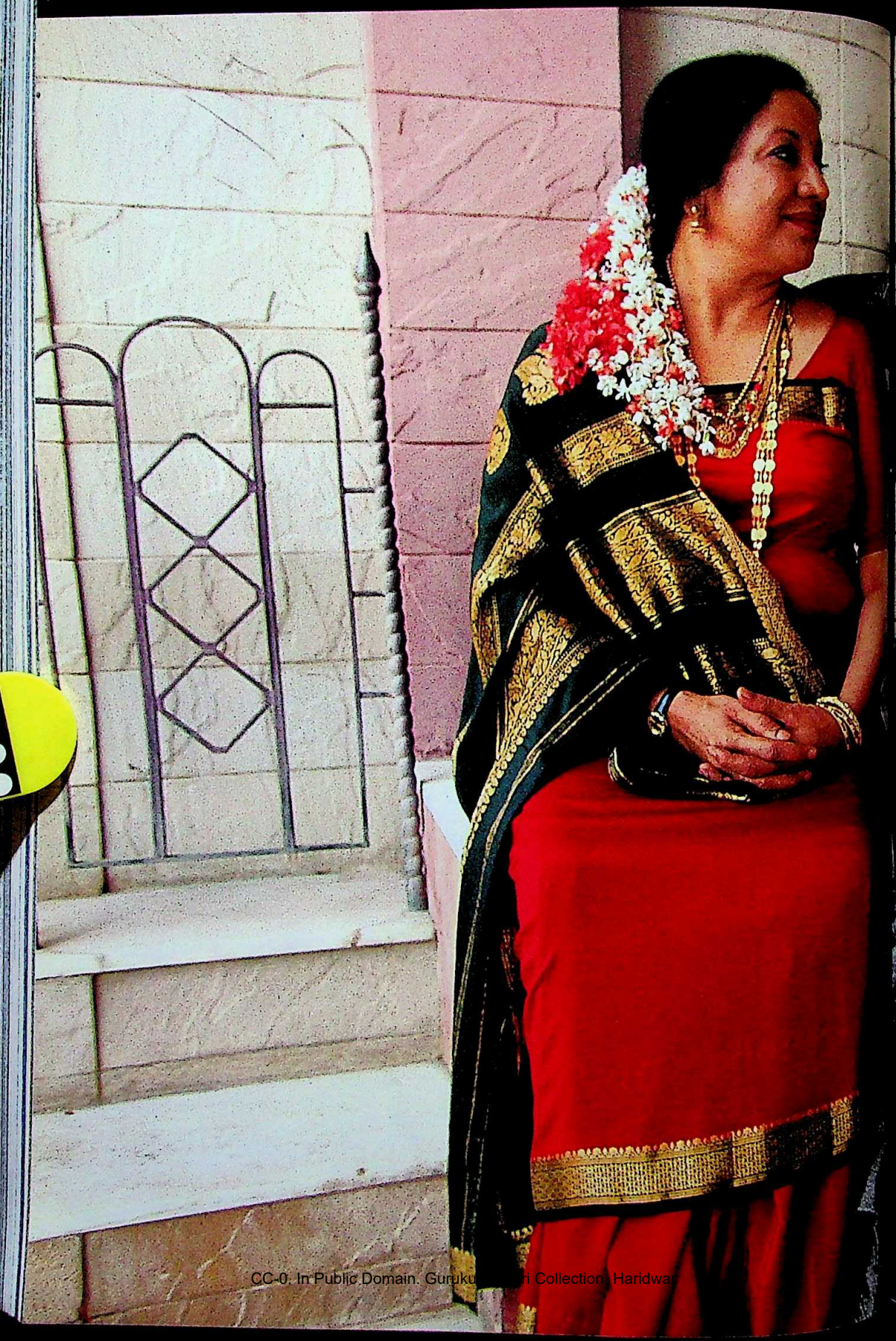
SOPHISTICATED LADIES They're well-off, well educated, widely traveled, fluent in several languages. Nakshatra Reddy is a biochemist, married to a prosperous businessman in Mumbai (formerly Bombay). Her daughter Meghana (in a PVC catsuit of her own



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design) is a model and former host on the music video channel VTV. Another daughter models full-time, and a third works for Swatch, the trendy Swiss watchmaker. They are elites, and the global marketplace for goods, information, and style is their corner store.

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Goods move. People move. Ideas move. And cultures change.

By ERLA ZWINGLE
Photographs by JOE McNALLY

ONCE I STARTED LOOKING for them, these moments were everywhere: That I should be sitting in a coffee shop in London drinking Italian espresso served by an Algerian waiter to the strains of the Beach Boys singing "I wish they all could be California girls. . . ." Or hanging around a pub in New Delhi that serves Lebanese cuisine to the music of a Filipino band in rooms decorated with barrels of Irish stout, a stuffed hippo head, and a vintage poster announcing the Grand Ole Opry concert to be given at the high school in Douglas, Georgia. Some Japanese are fanatics for flamenco. Denmark imports five times as much Italian pasta as it did ten years ago. The classic American blond Barbie doll now comes in some 30 national varieties—and this year emerged as Austrian and Moroccan.

Today we are in the throes of a worldwide reformation of cultures, a tectonic shift of habits and dreams called, in the curious argot of social scientists, "globalization." It's an inexact term for a wild assortment of changes in politics, business, health, entertainment. "Modern industry has established the world market. . . . All old-established national industries. . . . are dislodged by new industries whose . . . products are consumed, not only at home, but in every quarter of the globe. In place of the old wants . . . we find new wants, requiring for their satisfaction the products of distant lands and climes." Karl Marx and Friedrich Engels wrote this 150 years ago in *The Communist Manifesto.* Their statement now describes an ordinary fact of life.

How people feel about this depends a great deal on where they live and how much money they have. Yet globalization, as one report stated, "is a reality, not a choice." Humans have been weaving commercial and cultural connections since before the first camel caravan ventured afield. In the 19th century the postal service, newspapers, transcontinental railroads, and great steam-powered ships wrought fundamental changes. Telegraph, telephone, radio, and television tied tighter and more intricate knots between individuals and the wider world. Now computers, the Internet, cellular phones, cable TV, and cheaper jet transportation have accelerated and complicated these connections.

Still, the basic dynamic remains the same: Goods move. People move. Ideas move. And cultures change. The difference now is the speed and scope of these changes. It took television 13 years to acquire 50 million users; the Internet took only five.

Not everyone is happy about this. Some Western social scientists and anthropologists, and not a few foreign politicians, believe that a sort of cultural cloning will result from what they regard as the

ERLA ZWINGLE, a former GEOGRAPHIC editor who now lives in Venice, Italy, has written on subjects from Morocco to Australia's outback. JOE MCNALLY is a frequent contributor who chronicled John Glenn's return to space for the June 1999 issue.

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COMPUTER ENHANCEMENT BY INDUSTRIAL LIGHT & MAGIC

Filmmaker George Lucas appears with denizens of his elaborate galactic saga—both the tangible and those that spring only from digital workstations. Epics can be lucrative: Homer may never have licensed his Greek heroes as action toys or collectible figurines, but Star Wars *global merchandising has earned more than 4.5 billion dollars in profits since 1977.*

"cultural assault" of McDonald's, Coca-Cola, Disney, Nike, MTV, and the English language itself—more than a fifth of all the people in the world now speak English to some degree. Whatever their backgrounds or agendas, these critics are convinced that Western—often equated with American—influences will flatten every cultural crease, producing, as one observer terms it, one big "McWorld."

Popular factions sprout to exploit nationalist anxieties. In China, where xenophobia and economic ambition have often struggled for the upper hand, a recent book called *China Can Say No* became a best-seller by attacking what it considers the Chinese willingness to believe blindly in foreign things, advising Chinese travelers to not fly on a Boeing 777 and suggesting that Hollywood be burned.

There are many Westerners among the denouncers of Western cultural influences, but James Watson, a Harvard anthropologist, isn't one of them. "The lives of Chinese villagers I know are infinitely better now than they were 30 years ago," he says. "China has become more open partly because of the demands of ordinary people. They *want* to become part of the world—I would say globalism is the major force for democracy in China. People want refrigerators, stereos, CD players. I feel it's a moral obligation not to say: 'Those people out there should continue to live in a museum while we will have showers that work.' "

Westernization, I discovered over months of study and travel, is a phenomenon shot through with inconsistencies and populated by very strange bedfellows. Critics of Western culture blast Coke and Hollywood but not organ transplants and computers. Boosters of

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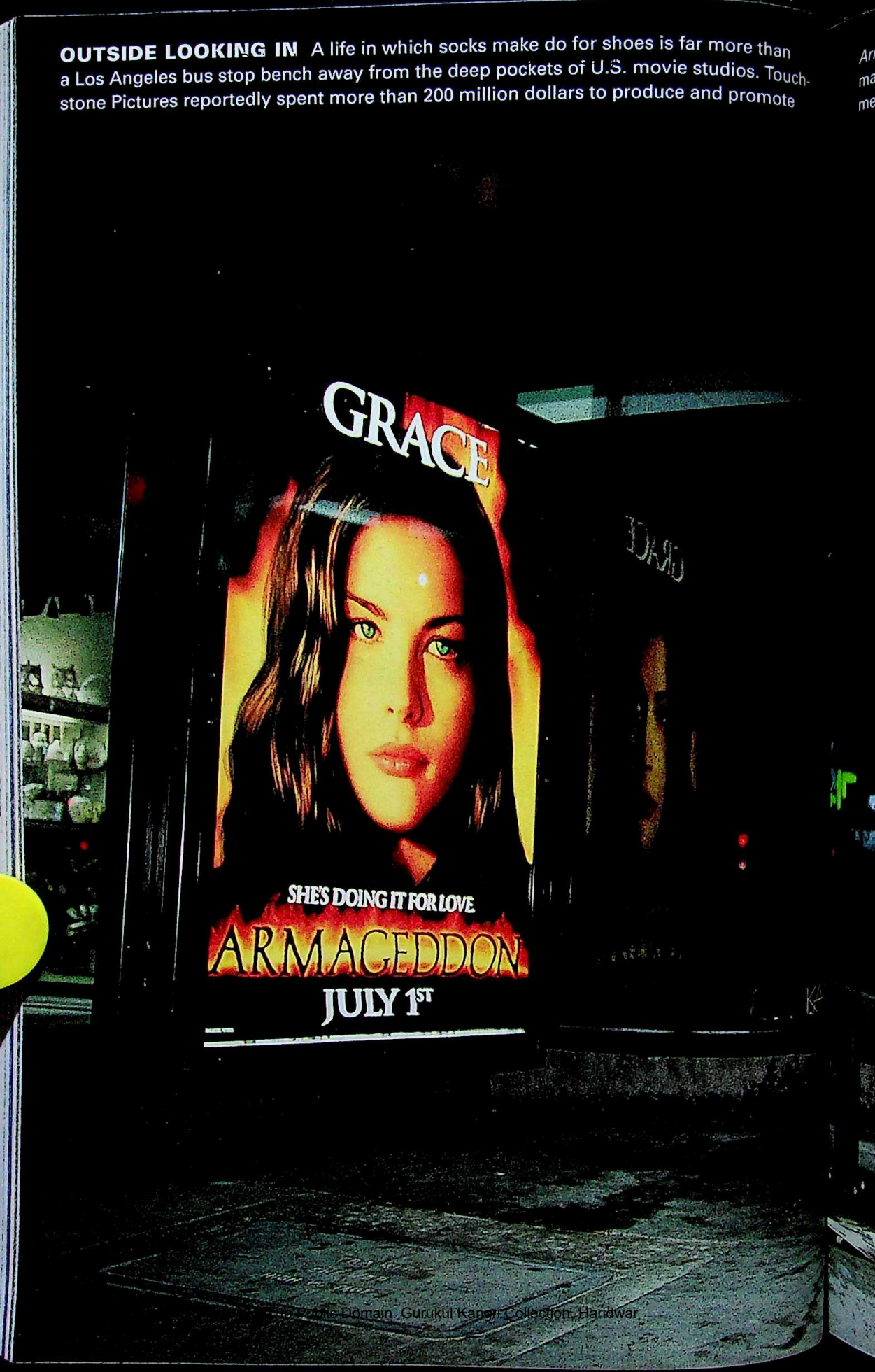
OUTSIDE LOOKING IN A life in which socks make do for shoes is far more than a Los Angeles bus stop bench away from the deep pockets of U.S. movie studios. Touchstone Pictures reportedly spent more than 200 million dollars to produce and promote



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Armageddon. Ticket sales for the 1998 thriller topped 500 million dollars worldwide. Filmmakers in other countries often feel overwhelmed by the spending power of American media, part of what Canadian writer Margaret Atwood calls "the great star-spangled Them."

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Western culture can point to increased efforts to preserve and protect the environment. Yet they make no mention of some less salubrious aspects of Western culture, such as cigarettes and automobiles, which, even as they are being eagerly adopted in the developing world, are having disastrous effects. Apparently westernization is not a straight road to hell, or to paradise either.

But I also discovered that cultures are as resourceful, resilient, and unpredictable as the people who compose them. In Los Angeles, the ostensible fountainhead of world cultural degradation, I saw more diversity than I could ever have supposed—at Hollywood High School the student body represents 32 different languages. In Shanghai I found that the television show *Sesame Street* has been redesigned by Chinese educators to teach Chinese values and traditions. "We borrowed an American box," one told me, "and put Chinese content into it." In India, where there are more than 400 languages and several very strict religions, McDonald's serves mutton instead of beef and offers a vegetarian menu acceptable to even the most orthodox Hindu.

"I used to say that Peoria will look like Paris, and Beijing will look like Boston," said Marshall W. Fishwick, professor of American studies at Virginia Tech, "but now I'm not so sure."

FOR HUNDREDS OF YEARS, women in Africa, the Middle East, and South Asia have decorated their bodies with designs painted with a paste made from henna leaves. In India this practice is called *mehndi.* It's also called mehndi in Los Angeles, and as I write, it is considered a very cool thing to do, though by the time you read this it may have followed the love song from *Titanic* into oblivion.

One sunny September afternoon I was sitting in a spacious frame house in West Hollywood watching a French artist named Pascal Giacomini carefully draw swirls down the bare arm of a Hispanic girl to the rhythm of Brazilian samba music. "It's a temporary, painless tattoo—in two weeks it's gone," Pascal explained softly as he concentrated on the little dots he was making around the curving tendrils near her elbow. "Henna is tied to a wedding tradition, and it has no connection with drugs or rock-and-roll. It's an art form with roots. Now it's hugely popular—in Japan, Argentina, Sweden, Greece. My Guatemalan maid does it. . . ."

He took my left hand and drew a sinuous uncoiling circle; it trailed down my middle finger and ended with a dot at the cuticle.

Pascal has developed a mehndi kit, which he sells through Learningsmith and more than a hundred other outlets. "In America, people

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will grab anything and run with it," Pascal said. Incorrigibly curious, ravenous for novelty, Americans love to experiment with ethnic food, clothes, words. Mehndi is just one of the many bits of exotica to become the mall rat's latest diversion. And when something becomes fashion, it becomes commercial.

The critical mass of teenagers—800 million in the world, the most there have ever been—with time and money to spend is one of the powerful engines of merging global cultures. Kids travel, they hang out, and above all they buy stuff. I'm sorry to say I failed to discover who was the first teenager to put his baseball cap on backward. Or the first one to copy him. But I do know that rap music, which sprang from the inner-city ghettos, began making big money only when rebellious white teenagers started buying it. But how can anyone predict what kids are going to want? Companies urgently need to know, so consultants have sprung up to forecast trends. They're called "cool hunters," and Amanda Freeman took me in hand one morning to explain how it works.

Amanda, who is 22, works for a New York-based company called Youth Intelligence and has come to Los Angeles to conduct one of

Breakfasting monks in saffron robes excite no particular curiosity at a Denny's restaurant in California. A dozen or more Theravada Buddhist monks, most ordained in Thailand, serve five-year "tours of duty" at Wat Thai of Los Angeles. The temple provides a spiritual and cultural center for the local Thai community—some 40,000 strong.

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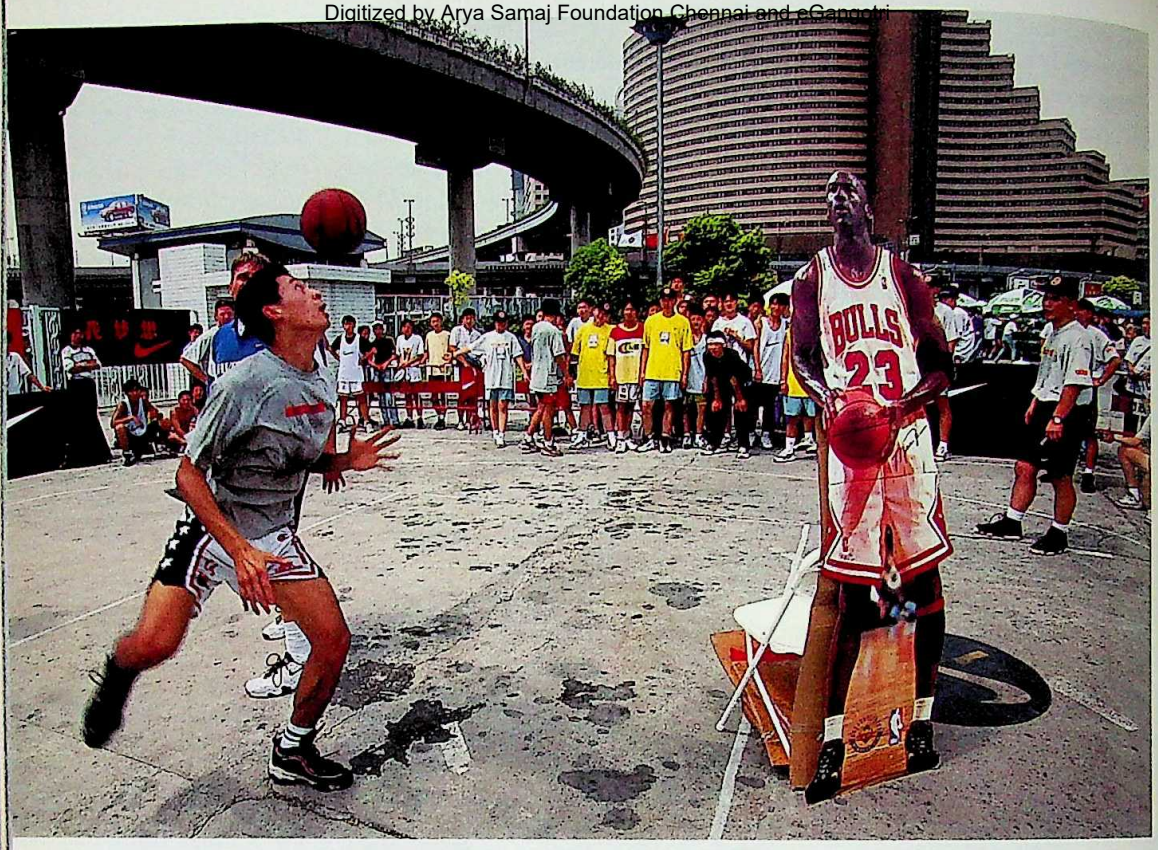

three annual surveys, whose results go to such clients as Sprint and MTV. She has shoulder-length brown hair and is wearing a knee-length brocade skirt and simple black wrap top. Amanda looks very cool to me, but she says no. "The funny thing about my work is that you don't have to be cool to do it," she says. "You just have to have the eye."

We go to a smallish '50s-style diner in Los Feliz, a slightly seedy pocket east of Hollywood that has just become trendy. Then we wander through a few of the thrift shops. "If it's not going to be affordable," Amanda remarks, "it's never going to catch on."

What trends does she see forming now? "People aren't as health conscious as they were, so we're seeing fondue and crepes," she answers. "Another trend—the home is becoming more of a social place again. And travel's huge right now—you go to a place and bring stuff back.

"It's really hard to be original these days, so the easiest way to come up with new stuff is to mix things that already exist. Fusion is going to be the huge term that everybody's going to use," she concludes. "There's going to be more blending, like Spanish music and punk—things that are so unrelated."

LOS ANGELES IS FUSION CENTRAL, where cultures mix and morph. Take Tom Sloper and mah-jongg. Tom is a computer geek who is also a mah-jongg fanatic. This being America, he has found a way to marry these two passions and sell the result. He has designed a software program, *Shanghai: Dynasty*, that enables you to play mah-jongg on the Internet. This ancient Chinese game involves both strategy and luck, and it is still played all over Asia in small rooms that are full of smoke and the ceaseless click of the

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chunky plastic tiles and the fierce concentration of the players. It is also played by rich society women at country clubs in Beverly Hills and in apartments on Manhattan's Upper West Side. But Tom, 50, was playing it at his desk in Los Angeles one evening in the silence of a nearly empty office building.

Actually, he only appeared to be alone. His glowing computer screen showed a game already in progress with several habitual partners: "Blue Whale," a man in Cologne, Germany, where the local time was 4:30 a.m.; Russ, from Dayton, Ohio; and "yobydderf" (or Freddyboy spelled backward), a Chinese-American who lives in Edina, Minnesota. (According to one study 64 percent of Asian-American families are linked to the Internet, compared with 33 percent of all U.S. families.) Tom played effortlessly as we talked.

"I've learned about 11 different styles of mah-jongg," he told me with that detached friendliness of those whose true connection is with machines. "There are a couple of different ways of playing it in America. We usually play Chinese mah-jongg. The Japanese style is the most challenging—more hoops to jump through."

I watched the little tiles, like the cards in solitaire, bounce around the screen. From what I gathered, it has to do with collecting similar or sequential tiles of dots, characters, bamboos, winds, or dragons into groupings called pungs, kongs, or, in some cases, chows. As Tom played, he and his partners conversed by typing short comments to each other.

"I'm trying to coax Fred to be a better sport—he kind of gloats too much when he wins, and he really likes the Spice Girls too," Tom remarked as his fingers gripped the mouse. "Oh, he got a pung of dragons, I hate him. . . ." The mouse clicked, some tiles shifted.

Does he ever play with real people? "Oh yeah," Tom replied. "Once a week at the office in the evening, and Thursday at lunch." A new name appeared on the screen. "There's Fred's mother. Can't be, they're in Vegas. Oh, it must be his sister. There's my eight dot. TJ's online too, she's the one from Wales—a real night owl. *(Continued on page 24)*

Some 1,600 Shanghai teens turned out for a basketball tournament run by Nike. Many lined up for a chance to shoot over a life-size cutout of American sports icon Michael Jordan. Says Nike's Terry Rhoads, "He's the most popular man in China who's never been to China."

Fans of Big Bird's Chinese cousin, Da Niao (below), are just as devoted. Called Zhima Jie *on Shanghai Television,* Sesame Street *now stretches from Mr. Hooper's store to the Great Wall of China and beyond, reaching more than 120 million viewers.*

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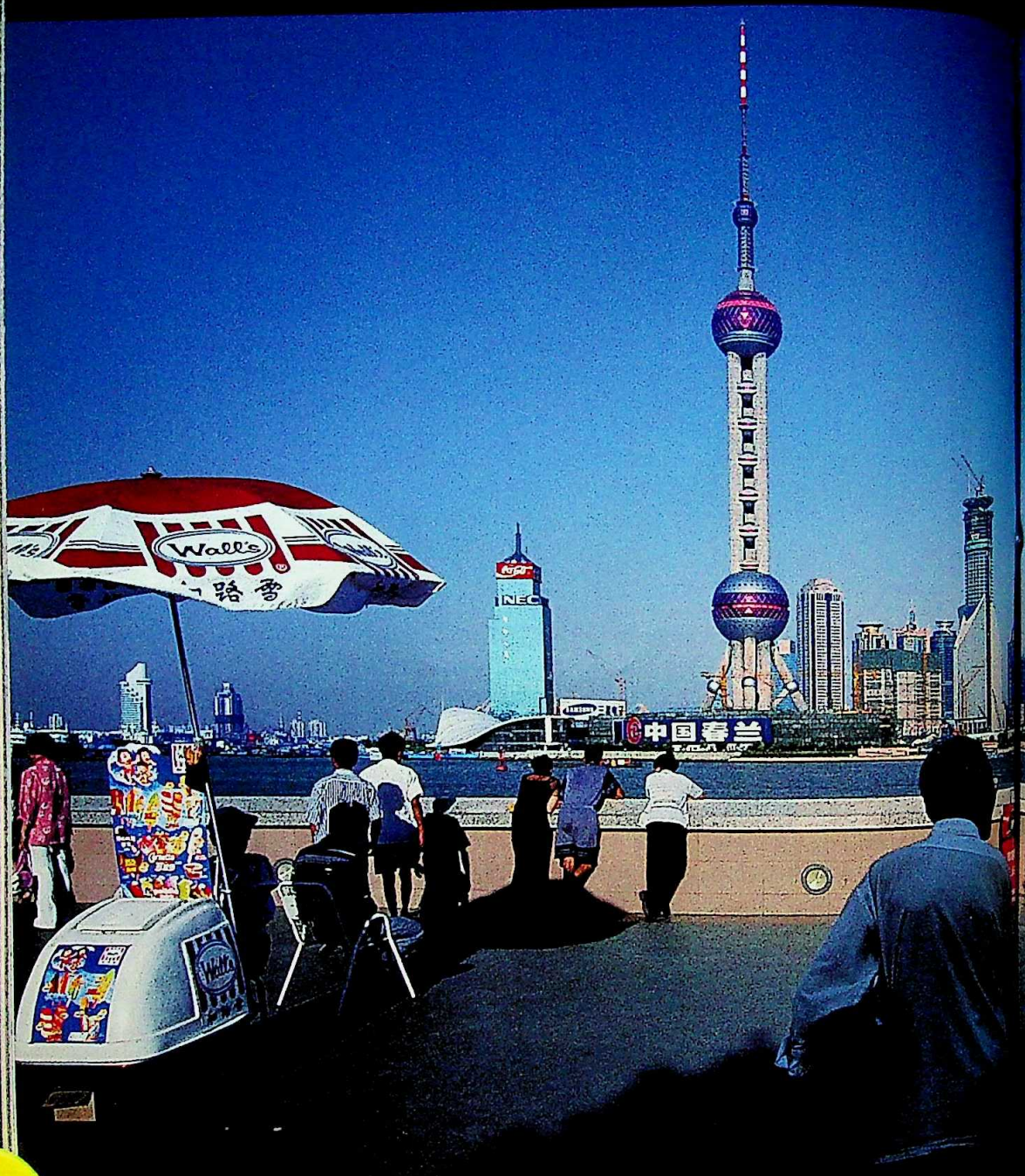
SHANGHAI RISING Punctuated by the 1,500-foot-tall exclamation point of the Oriental Pearl TV Tower, a skyscraping special economic zone scrawls along the Huangpu River. Foreign investors have pumped more than 15 billion dollars into the Pudong New Area.



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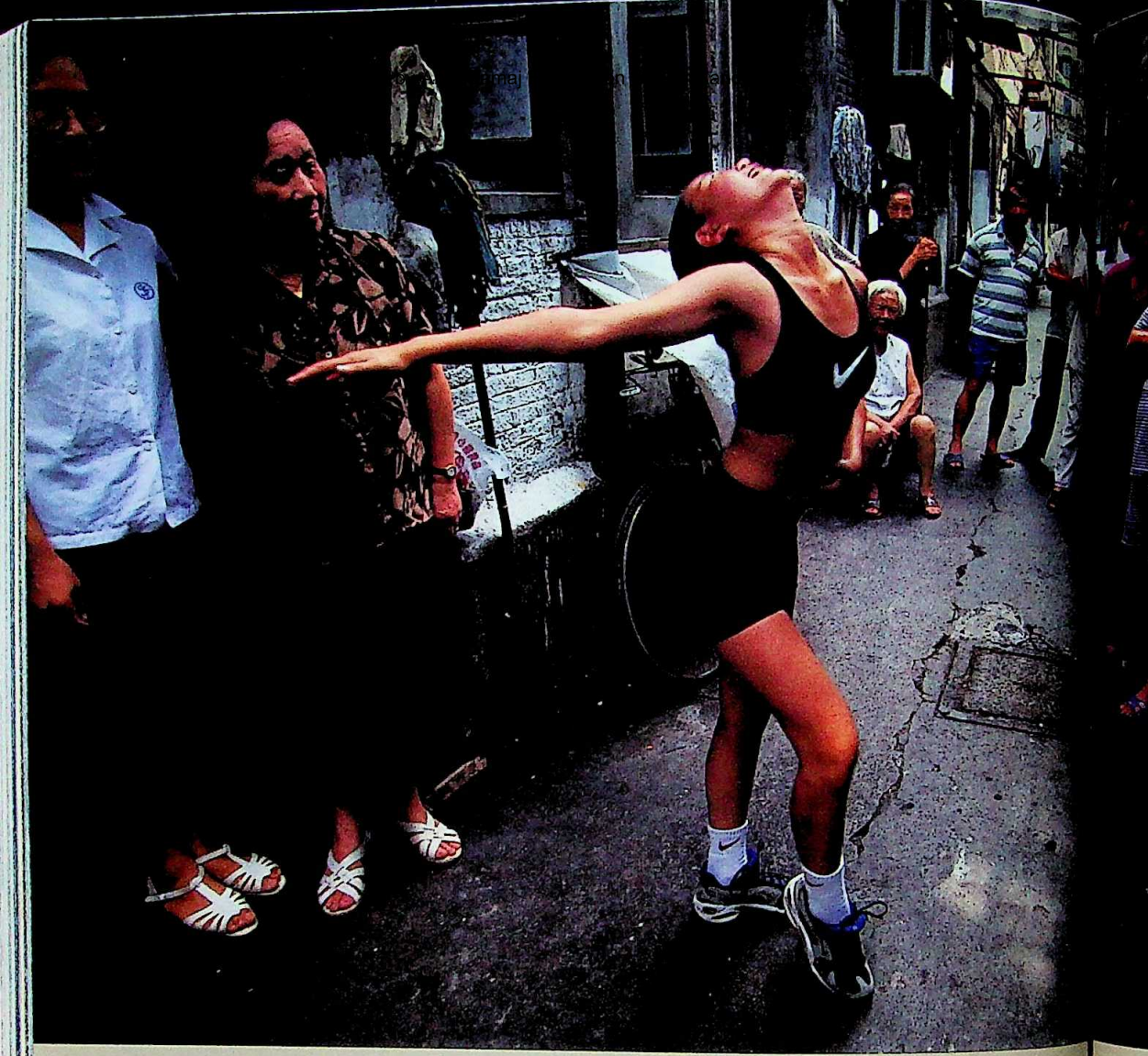
In 1990 it was farmland and paddies. "Now," reports *Shanghai Talk* editor Lily Tung, "it's where you'll find the biggest of everything: the tallest tower in Asia, the largest department store on the continent, and—coming soon—the tallest building in the world."



我梦想

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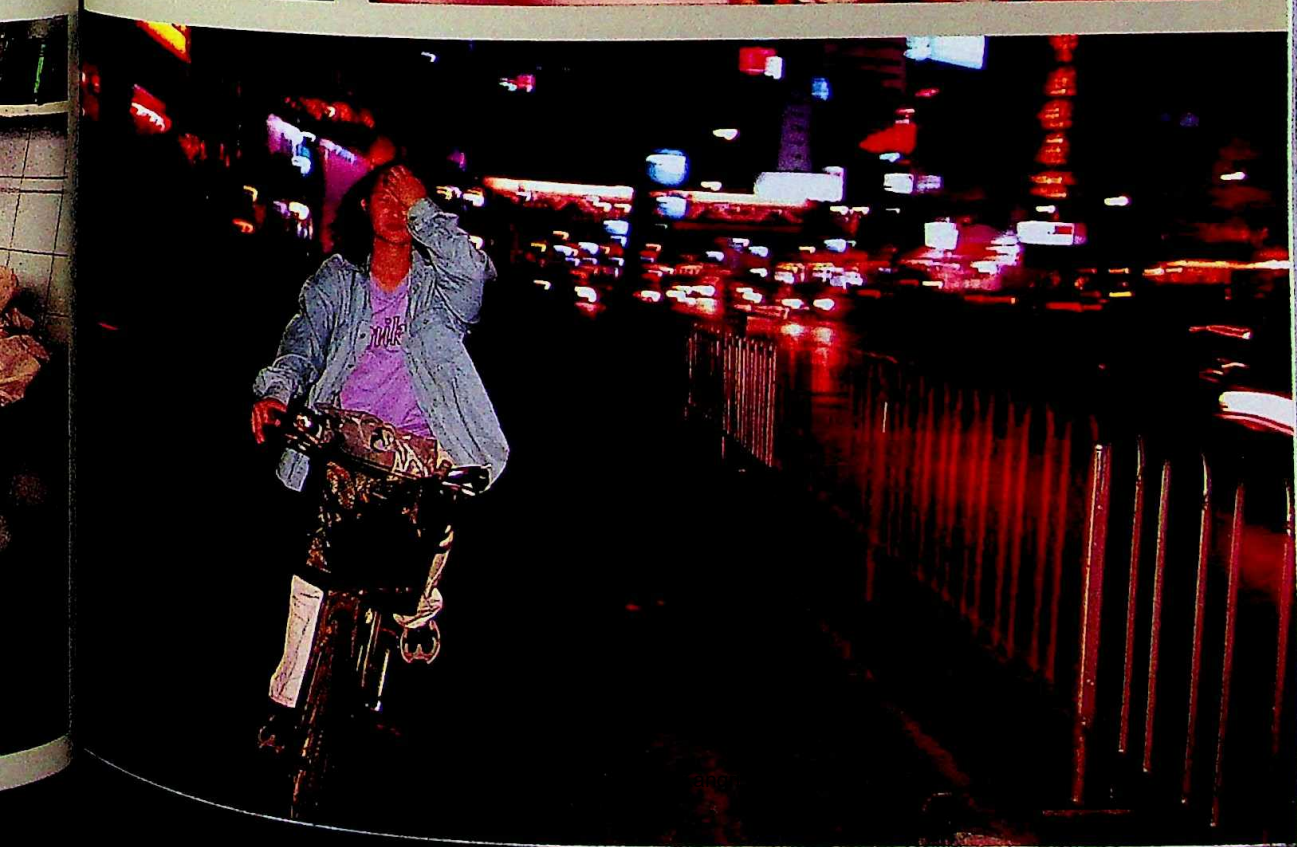
"I think I'm like most young people. . . ." She likes jeans and singer Mariah Carey, expects to watch Disney movies with her kids someday, and thinks her mother (bottom left) is too critical of fads like midriff-baring shirts. In the alley behind her home (left) 17-year-old Shanghai dynamo Zhou Die Die practices hip-hop moves for appearances with Nike's Dance Team. At the Zhong Ya Hotel restaurant (below) she trains for a hotel-management diploma, putting in 12 hours every other day and bicycling home late at night (bottom). "Once I start earning money," she says, "the first thing I want to do is see Paris." But Zhou also sees new economic opportunity clouding some Chinese lives: "There is more pressure to be rich," she worries. "People are never satisfied."



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She's getting married soon, and she lives with her fiancé, and sometimes he gets up and says, 'Get off that damn computer!'"

Tom played on into the night. At least it was night where I was. He, an American playing a Chinese game with people in Germany, Wales, Ohio, and Minnesota, was up in the cybersphere far above the level of time zones. It is a realm populated by individuals he's never met who may be more real to him than the people who live next door. "Can't be, they're in Vegas." The global village gets a fiber-optic party line.

IF IT SEEMS that life in the West has become a fast-forward blur, consider China. In just 20 years, since market forces were unleashed by economic reforms begun in 1978, life for many urban Chinese has changed drastically. A recent survey of 12 major cities showed that 97 percent of the respondents had televisions, and 88 percent had refrigerators and washing machines. Another study revealed that farmers are eating 48 percent more meat each year and 400 percent more fruit. *Cosmopolitan* magazine, plunging necklines and all, is read by 260,000 Chinese women every month.

I went to Shanghai to see how the cultural trends show up in the largest city in the world's most populous nation. It is also a city that has long been open to the West. General Motors, for example, set up its first Buick sales outlet in Shanghai in 1929; today GM has invested 1.5 billion dollars in a new plant there, the biggest Sino-American venture in China.

Once a city of elegant villas and imposing beaux arts office buildings facing the river with shoulders squared, Shanghai is currently ripping itself to ribbons. In a decade scores of gleaming new skyscrapers have

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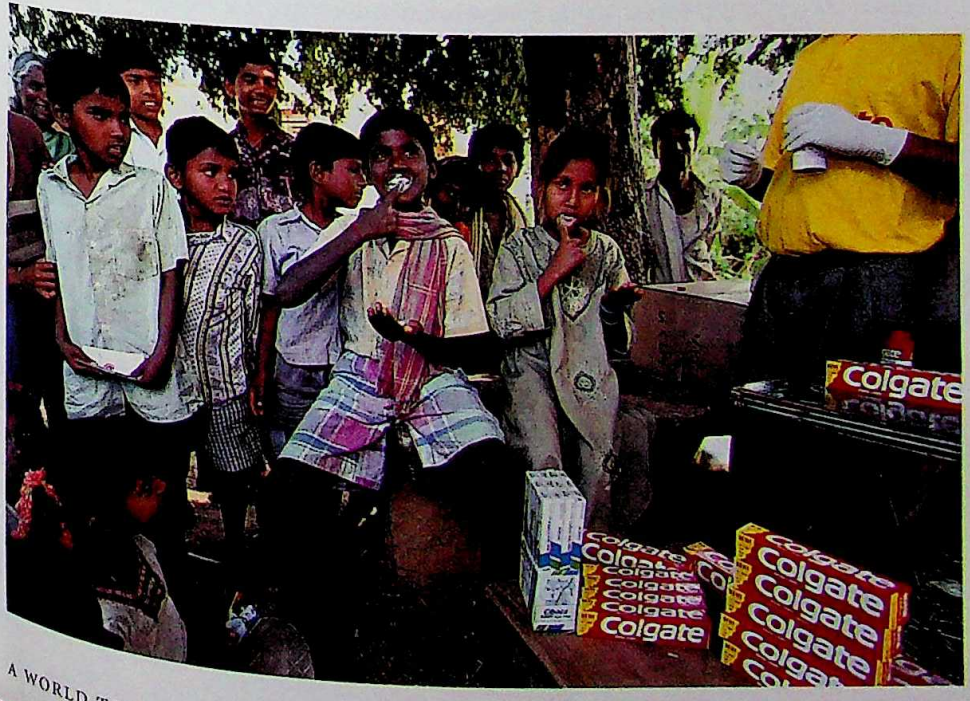
shot up to crowd and jostle the skyline, cramp the narrow winding streets, and choke the parks and open spaces with their sheer soaring presence (most are 80 percent vacant). Traffic crawls, even on the new multilane overpasses. But on the streets the women are dressed in bright colors, and many carry several shopping bags, especially on the Nanjing Road, which is lined with boutiques and malls. In its first two weeks of business the Gucci store took in a surprising $100,000.

"Maybe young women today don't know what it was like," says Wu Ying, editor in chief of the Chinese edition of the French fashion magazine *Elle*. "But ten years ago I wouldn't have imagined myself wearing this blouse." It was red, with white polka dots. "When people bought clothes, they thought 'How long will it last?' A housewife knew that most of the monthly salary would be spent on food, and now it's just a small part, so she can think about what to wear or where to travel. And now with refrigerators, we don't have to buy food every day."

As for the cultural dislocation this might bring: "People in Shanghai don't see it as a problem," said a young German businessman. "The Chinese are very good at dealing with ambiguity. It's accepted—'It's very different, but it's OK, so, so what?'"

Li Ping is a cardiologist who discovered Amway cosmetics two years ago and began what Americans call selling door-to-door. Because it's very difficult for an individual to start a business, direct sales have become the new road to prosperity for many enterprising Chinese. As incomes and curiosity about Western products have grown, companies such as Amway, Avon, Tupperware, and Mary Kay have made swift inroads. Amway, for example, has some 92,000 sales representatives who made almost one hundred million dollars in sales in 1998.

I went with Dr. Li to visit some of her clients. A compact, robust, middle-aged woman wearing a stylish white cotton dress with little brass stars scattered over the shoulders, Dr. Li made no secret of her enthusiasm for her new avocation. "In the past every person had a dream that they could do what they want," she said, "but they couldn't, because tradition wouldn't allow them to do it. I hope to build a clinic



Coca-Cola claims to own the world's best known commercial trademark. Passersby on Mumbai's busy Tulsi Pipe Road may notice the logos, but for a small girl and her family the corrugated metal walls and ragged plastic-sheeting roof aren't a billboard —they're home.

Advertising has little impact in villages like Kaggalipura (below), near Bangalore. So companies like toothpaste maker Colgate-Palmolive send out vans loaded with free samples, hoping to capture a profitable share of a vast market.

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for myself in the future. So I have to earn extra money, and Amway is a good chance. Because money doesn't fall from heaven."

Mrs. Gong Suihua has been a client for a year. She lives with her husband in a comfortable apartment with polished wood floors and two bedrooms; there is also a large Panasonic television with Sony speakers. She offered us coffee and pulled out photographs of her daughter in Los Angeles. Then Mrs. Gong settled down for a demonstration of the new facial products—cleanser and cream. "Age will destroy our skin. We need to take care of it," Dr. Li says as she works on her friend's face. "I'm a doctor, so I have some knowledge about beauty."

Mrs. Gong didn't take long to order several items. "I know the quality is very great," she said. "Even if the price is high, it's worth it. We feel confident buying this way because friends introduce the products."

The morning passed quickly. It seemed so unremarkable that I had to remind myself how revolutionary it really was. "This way has put new ideas into people's brains," Dr. Li said, her eyes shining. "It is helping you tap all your potential."

POTENTIAL: This is largely a Western concept. Set aside the makeup and skyscrapers, and it's clear that the truly great leap forward here is at the level of ideas. To really grasp this, I had only to witness the local performance of Shakespeare's *Macbeth* by the Hiu Kok Drama Association from Macau.

There we were at the Shanghai Theatre Academy, some 30 professors and students of literature and drama from all over China and I, on folding chairs around a space not unlike half of a basketball court. "I'm not going to be much help," murmured Zhang Fang, my interpreter. "I don't understand the Cantonese language, and most of these people don't either."

I had spoken earlier with the young director, Hui Koc Kun, known as Billy. He chose *Macbeth*, he said, because it represents so perfectly the current situation in Macau. This year the Portuguese colony will become part of China, and this is generating a great deal of anxiety. "I wanted to show the feeling of contradiction," he explained in tentative English. "Macbeth is a general. He's a hero. He wants to do the right thing. But everything takes him to a road—he doesn't want to be on that road, but things want him to take that path. The war, the environment, his wife. We have no choice in the modern city. You think you can choose, but actually you have no choice."

I thought I knew what to watch for, but the only characters I recognized were the three witches. Otherwise the small group, dressed in leotards and capes, spent most of an hour running in circles, leaping, and threatening to beat each other with long sticks. The lighting was heavy on shadows, with frequent strobelike flashes. Language wasn't a problem, as the actors mainly snarled and shrieked. Then they turned their backs to the audience and a few shouted "Free Macau!" in Cantonese. The lights went out, and for a moment the only sound in the darkness was the whirring of an expensive camera on auto-rewind.

This is China? It could have been a college campus anywhere in the West: the anguished students, the dubious adults, the political exploitation of the massacred classic. Until recently such a performance was unthinkable. It strained imagination that this could be the same

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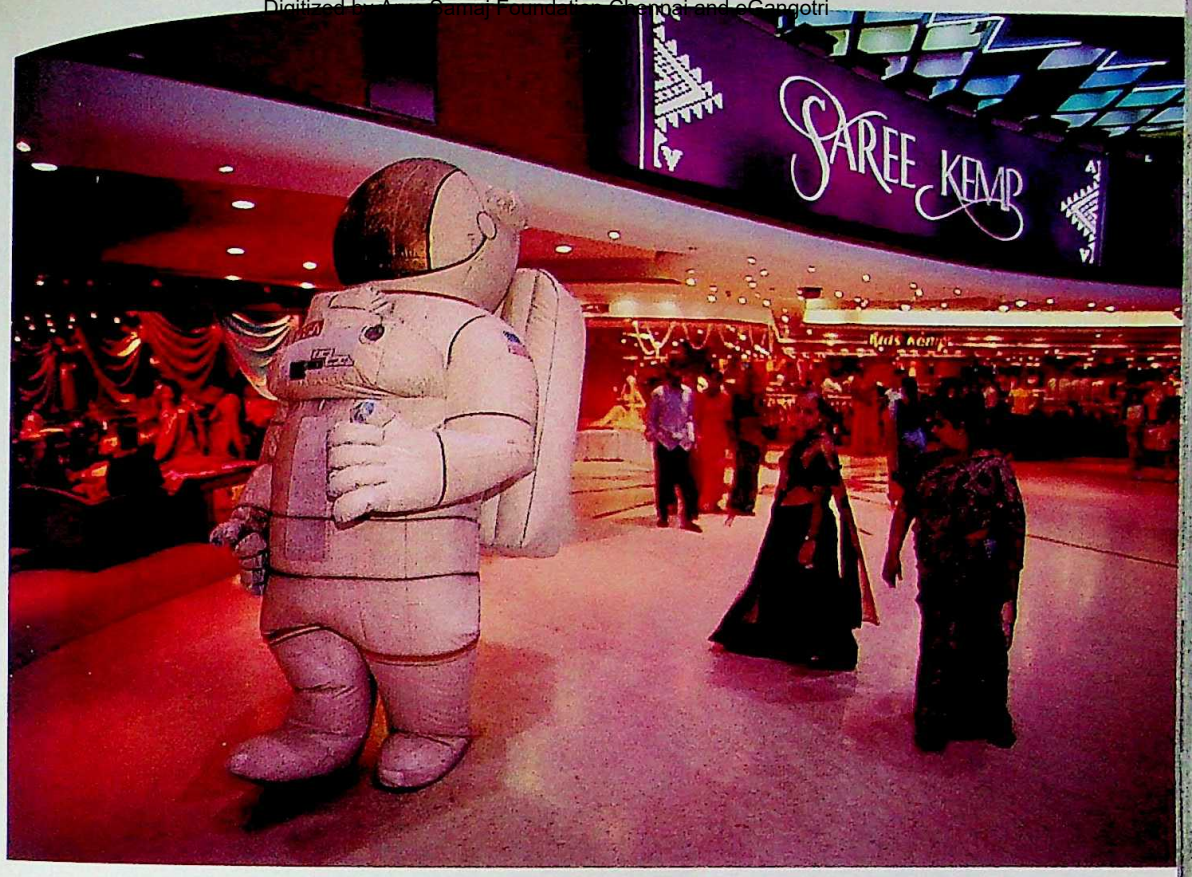

An inflated American astronaut entertains in Bangalore. Selling saris and children's toys, Kemp Fort is becoming an after-work hangout as its fanciful characters introduce Indian consumers to a mix of shopping and showbiz long familiar in the U.S. and Japan.

country where a generation ago the three most desired luxury items were wristwatches, bicycles, and sewing machines.

EARLY ON I REALIZED that I was going to need some type of compass to guide me through the wilds of global culture. So when I was in Los Angeles, I sought out Alvin Toffler, whose book *Future Shock* was published in 1970. In the nearly three decades since, he has developed and refined a number of interesting ideas, explained in *The Third Wave*, written with his wife, Heidi.

What do we know about the future now, I asked, that we didn't know before? "We now know that order grows out of chaos," he answered immediately. "You cannot have significant change, especially on the scale of Russia or China, without conflict. Not conflicts between East and West, or North and South, but 'wave' conflicts between industrially dominant countries and predominantly agrarian countries, or conflicts within countries making a transition from one to the other."

Waves, he explained, are major changes in civilization. The first wave came with the development of agriculture, the second with industry. Today we are in the midst of the third, which is based on information. "In 1956 something new began to happen, which amounts to the emergence of a new civilization," Toffler said. "It was in that year that U.S. service and knowledge workers outnumbered blue-collar factory workers. In 1957 Sputnik went up. Then jet aviation became commercial, television became universal, and computers began to be widely used. And with all these changes came changes in culture.

"What's happening now is the trisection of world power," he

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ENTERTAINMENT WITHOUT BOUNDARIES For 100 rupees—$2.34—a month, even Mumbai's slum-dwelling families can have access to more than 50 cable television channels. A decade ago one government-run channel aired nationwide for just a few hours a

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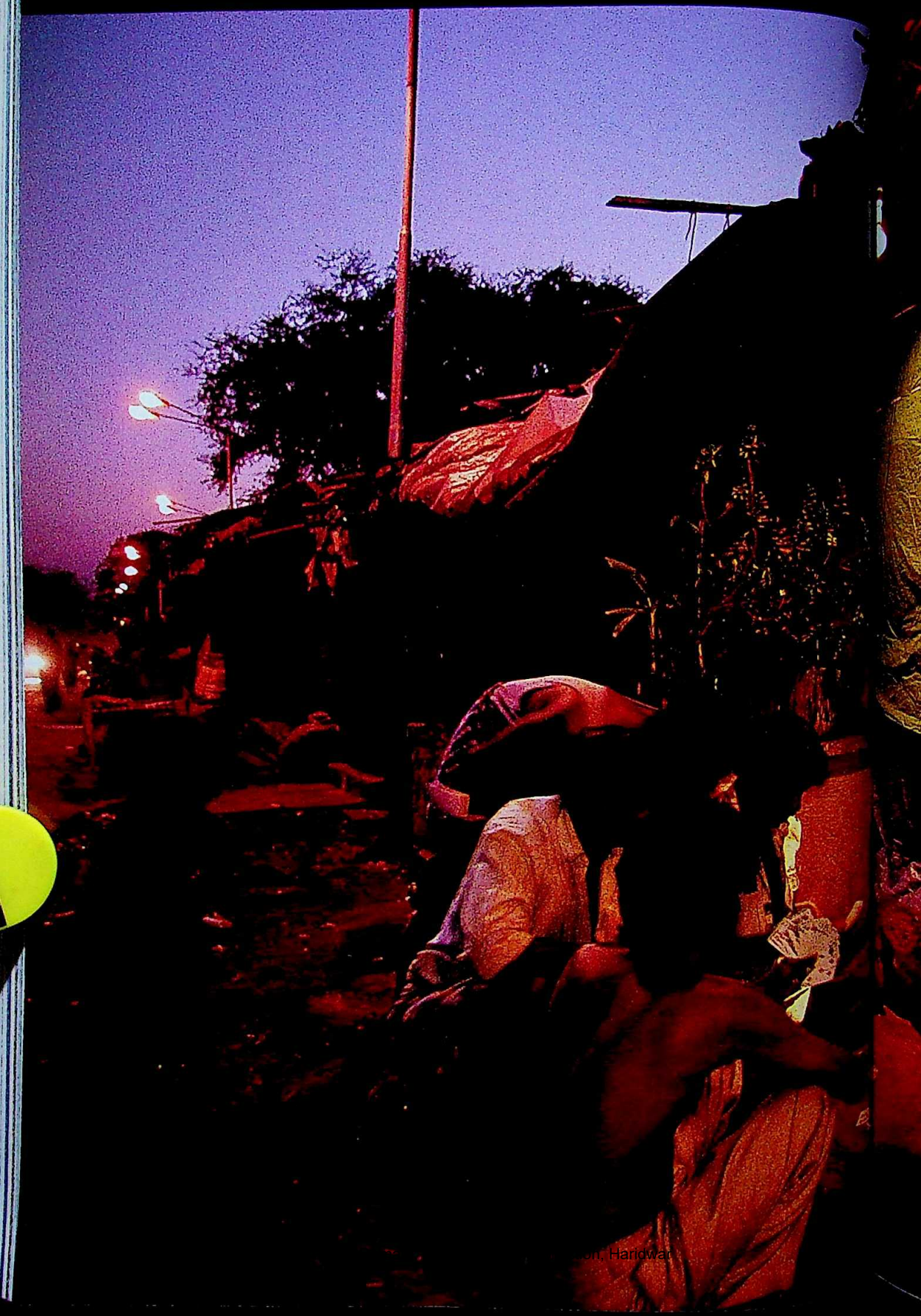

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day. Today state and commercial television producers offer local-language talk shows, game shows, soap operas, music videos, and news, along with an alphabet soup of imports—TNT, MTV, CNN, ESPN—and export Indian programming to 50 other nations.

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continued. "Agrarian nations on the bottom, smokestack countries in between, and knowledge-based economies on top." There are a number of countries—Brazil, for example—where all three civilizations coexist and collide.

"Culturally we'll see big changes," Toffler said. "You're going to turn on your TV and get Nigerian TV and Fijian TV in your own language." Also, some experts predict that the TV of the future, with 500 cable channels, may be used by smaller groups to foster their separate, distinctive cultures and languages.

"People ask, 'Can we become third wave and still remain Chinese?' Yes," Toffler says. "You can have a unique culture made of your core culture. But you'll be the Chinese of the future, not of the past."

RAJAN BAKSHI is a good example of the Indian of the future. He is a lawyer and a cable TV entrepreneur in New Delhi, brash, energetic, and making money. He, for one, has no interest in clinging to India's vast and elaborate past. "I think periodic upheavals are part of the regeneration process," he told me. "No culture exists in a vacuum. It all comes from somewhere. Ancient customs were modern at one time."

India, like China, teems with a billion people. But the contrast between the traditional and the new seems sharper and more ironic in a country that has nuclear power but no four-lane highways linking its major cities; that has some four million doctors and ranks among the world's top five countries in computer software production but where nearly half the population can't read or write.

In 1991 India began opening its economy to wider trade, and the United States quickly became its primary trading and investment partner—687 million dollars invested in 1997, almost three times as much as the year before. But promoters of global culture may have expected too much. Foreign companies were thrilled by sheer numbers—an estimated 150 million potential middle-income consumers—without knowing that "middle income" in India often connotes an annual per capita amount of only about 1,500 dollars. Many multinationals, from McDonald's to Panasonic, have had to accept paper-thin profit margins to stay afloat in India.

And while some politicians rail against "cultural pollution," they make no mention of the fact that many foreign companies have "gone native." Revlon, for instance, has adapted the color palette and composition of its cosmetics to suit the Indian skin and climate, and when MTV added an India-dedicated network with Indian performers, its ratings jumped. In Rajan Bakshi's opinion, foreign companies have also brought better job opportunities: "I think the average worker is better off with the multinationals," he said. "I see these young people at the satellite companies—girls who are 24, 25. If they'd been working for an Indian company, they'd have been exploited. Smart young people now have options because of the multinationals."

Anyway, Bakshi isn't impressed by the interminable debates about cultural purity. Neither is Yogendra Singh, a retired sociology professor, who explained: "India has lived with cultural pluralism for centuries. In fact, the history of India is based on linkages with other cultures."

Early one hot October morning I made my way along the banks of New Delhi's Yamuna River to Jamuna Basti, a massive slum that

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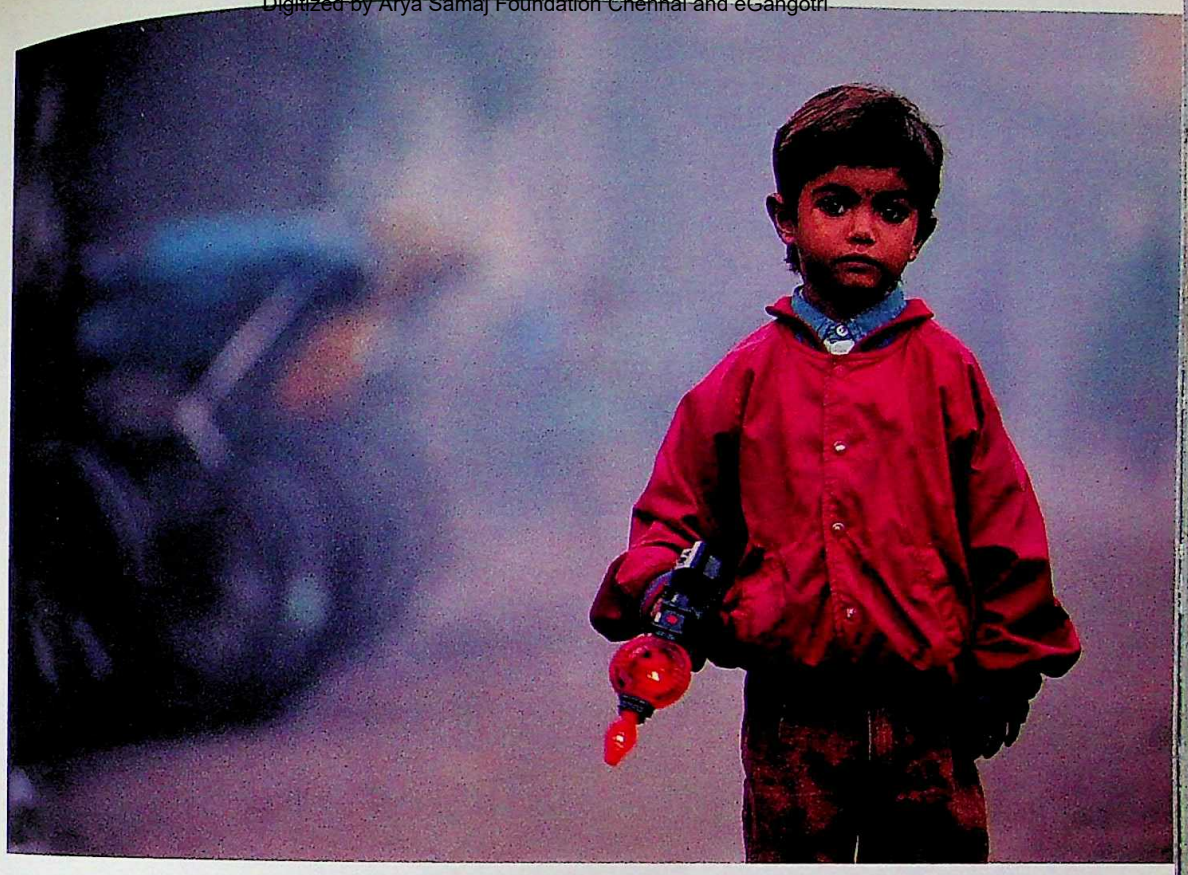

Toting a toy space gun, an Indian boy plays in a New Delhi slum. But more than poverty shadows six-year-old Rashid's future. Long-range missiles and nuclear weapons have proliferated in the region. As nations extend their destructive reach, neighbors grow even warier of each other.

swarms with hundreds of thousands of destitute people, many of them migrants from Bangladesh and the state of Bihar. The preoccupations of politicians and intellectuals—whether the government should block international calls that offer phone sex, say, or whether English is making India's national languages "look inadequate"—had yet to reach this outpost. Everyone here was talking about the astronomical price of onions. Almost overnight the cost reportedly spiked tenfold, and without onions you can hardly make anything worth eating.

Santosh Kumar, a 16-year-old boy who earns a hundred rupees ($2.34) a day driving a bicycle ricksha, led me to the riverbanks where the *dhobis*, or washermen, were working. The Yamuna was beige, loaded with detritus and raw sewage. Along the shore men and women were laboring over wet piles of clothes. Each dhobi took a heavy handful of laundry, hauled it out of the water, and swung it through the air, slinging it down hard against a block of reddish stone.

Walking on, we passed a café where a boy was stirring tea in a large pot. The café wasn't big, but at least it had two rooms. The hundreds of dwellings clustered around it were no more than rectangular patches of concrete with three low walls made of cinder block or brick or matting. Many were missing the front wall, so I could see straight into the back.

From the café came the unexpected glow of a black-and-white TV. Rajnai, the burly owner, was lounging in the doorway. He said he'd gotten the TV "to indulge his son."

"I paid 500 rupees for it secondhand," he said. "We watch mostly films and news." I looked surprised. "It's no big deal," he shrugged. "A lot of houses have television."

As we talked, a crowd quickly formed around me, and a slender,

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gray-haired woman named Zahida Khatoon pushed to the front. I asked what she thought of Coke and Pepsi. "If those companies come in and the local people benefit," she answered, "I don't object. But while the government is levying huge taxes on these foreign goods, we can't afford to send our kids to school. We don't care about multinationals. I can't feed my children. Our 'cultural roots'—it doesn't concern me."

I got into the car and headed back toward the main road, moving slowly through the masses of people, the cows, the dogs, the toddlers. A group of teenage boys squeezed past. One of them was wearing a T-shirt emblazoned "Titanic." I had to know why. He grinned shyly.

Had he seen the movie? "No," he replied. Did he know the story? "Not really," he said. "But my friend told me about it."

But why, I wondered, would a boy want to wear a T-shirt advertising something he knew nothing about, that represented no experience he'd ever had, that referred to nothing that mattered to him? The shirt, it occurred to me, didn't link him to the movie (or that damn song) or even to the West at large. But it did link him to his friend.

Linking: This is what the spread of global culture ultimately means. Goods will continue to move—from 1987 to 1995 local economies in

Applying henna paste to a well-stretched canvas, artist Nicole Baum brings Old World body art to Los Angeles. For her clients, like countless others in an ever more interconnected world, borrowed culture can serve very personal ends. "I was eight months pregnant," recalls Dara Paprock Brown. "I wanted to feel beautiful."

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California exported 200 percent more products, and businesses in Idaho 375 percent more. People move: It is cheaper for businesses to import talented employees than to train people at home. Ideas move: In Japan a generation of children raised with interactive computer games has sensed, at least at the cyber level, new possibilities. "What this exposure has given them is a direct sense . . . of asking the 'what if' questions they could never comfortably ask before (because of the Shinto superstition that saying a thing would make it happen)," wrote Kenichi Ohmae in *The End of the Nation State.* "The implicit message in all this . . . is that it is possible to actively take control of one's situation or circumstances and, thereby, to change one's fate. . . . For the Japanese, this is an entirely new way of thinking."

CHANGE: It's a reality, not a choice. But what will be its true driving force? Cultures don't become more uniform; instead, both old and new tend to transform each other. The late philosopher Isaiah Berlin believed that, rather than aspire to some utopian ideal, a society should strive for something else: "not that we agree with each other," his biographer explained, "but that we can understand each other."

In Shanghai one October evening I joined a group gathered in a small, sterile hotel meeting room. It was the eve of Yom Kippur, the Jewish Day of Atonement, and there were diplomats, teachers, and businessmen from many Western countries. Elegant women with lively children, single men, young fathers. Shalom Greenberg, a young Jew from Israel married to an American, was presiding over his first High Holy Days as rabbi of the infant congregation.

"It's part of the Jewish history that Jews went all over the world," Rabbi Greenberg reflected. "They received a lot from local cultures, but they also kept their own identity."

The solemn liturgy proceeded, unchanged over thousands of years and hundreds of alien cultures: "Create in me a clean heart, O God, and renew a right spirit within me," he intoned. I'm neither Jewish nor Chinese, but sitting there I didn't feel foreign—I felt at home. The penitence may have been Jewish, but the aspiration was universal.

Global culture doesn't mean just more TV sets and Nike shoes. Linking is humanity's natural impulse, its common destiny. But the ties that bind people around the world are not merely technological or commercial. They are the powerful cords of the heart. □

Read more from Erla Zwingle about global culture at *www.nationalgeographic.com/2000/culture/global.*

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ALEXANDRIA, CORDOBA, AND NEW YORK

Tale of T

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# of Three Cities

Celestial in shape and ambition, a planetarium rises over the dusty soils of Alexandria, Egypt. It is part of a new library meant to emulate the famed Ptolemaic library and museum that made Alexandria a cultural beacon before the first century A.D. Alexandria in ancient times, Córdoba, Spain, in the tenth century, and New York City today—each helped shape the culture of an age. Marked by both glory and strife, these cities hold lessons for the urban stars of the next millennium.

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MAKESHIFT MOSQUE Kneeling in reverent prayer at Alexandria's train station, Muslims display a fervor reminiscent of the ancient city—but a uniformity that would have been rare. Though ruled by Rome, first-century Alexandrians worshiped a blend of Egyptian,

Greek, and Roman deities, the composite god Serapis chief among them. Tolerance of varied faiths fostered philosophical debate among pagans, Jews, and Christians. Islam arrived with the Arab conquest in A.D. 641 and now claims the majority of the population.

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"The test of civilization is the power of drawing the most benefit out of cities."

—RALPH WALDO EMERSON

By JOEL L. SWERDLOW
ASSISTANT EDITOR
Photographs by STUART FRANKLIN

SMOKE AND THE FRAGRANCE OF ROASTING QUAIL float up from long charcoal grills lining the perimeter of Suq el-Attarine, the Market of Scents, in Alexandria, Egypt. It is October, the season when quail fly south from Europe, tire over the Mediterranean Sea, land on beaches, and are easily trapped. Along sidewalks men sit on benches and puff apple-cured tobacco through water pipes called *sheesha*. Some play dominoes. Above us hang the purple flowers of jacaranda trees.

The tranquil scene recalls earlier times in the city that Alexander the Great founded more than 2,300 years ago. But as I stroll from the marketplace toward the harbor, I am clearly in a modern city. Apartment buildings, home to most of Alexandria's nearly three and a half million people, surround me. Traffic jams the streets. Supermarkets, cell phones, motorcycles, and teenagers in baseball caps are everywhere.

Nearly half the world's population lives in cities. The number of megacities—those with populations of more than ten million—will exceed two dozen by 2015, up from fourteen in 1995.

All cities share certain characteristics. They are places to buy and sell, to worship, to share companionship. They are where new ideas trigger changes in science and art, where cultures meet and evolve. But why and where do cities, these centers of trade and knowledge, grow? What causes some to flourish and others to fade? I am in Alexandria at the beginning of my journey to three great cities to seek the answers.

I have begun here because in A.D. 1 this was one of the few international cities. Part of Africa, close to Arabia, and home to Europeans from Greece and Rome, Alexandria was a crossroads for trade that ranged from China to Britain. Strabo, a geographer in the first century A.D., called Alexandria "the greatest emporium in the inhabited world." After Alexandria I will visit Córdoba, Spain, western Europe's largest city in A.D. 1000, now a modest town supported mainly by agriculture. In its prime Córdoba was, in the words of one observer, "the mother of towns; the abode of the good and godly, the homeland of wisdom." My travels will end in New York City, a modern epicenter of finance and culture. New York, writes Joan Didion, is "an infinitely romantic notion, the mysterious nexus of all love and money and power."

Dodging cars speeding along El-Horreyah Avenue, Alexandria's busiest street, I arrive at the waterfront. I see small fishing boats at anchor, young boys jumping off rocks into the water, and, beyond, the natural harbor that Alexander the Great saw in 331 B.C.

Alexander's engineers realized that Mediterranean currents running west to east would keep the harbor navigable and free of Nile River silt. They also knew that the Island of Pharos, if joined to the mainland

Frequent contributor STUART FRANKLIN photographed the Galápagos Islands for the April 1999 issue.

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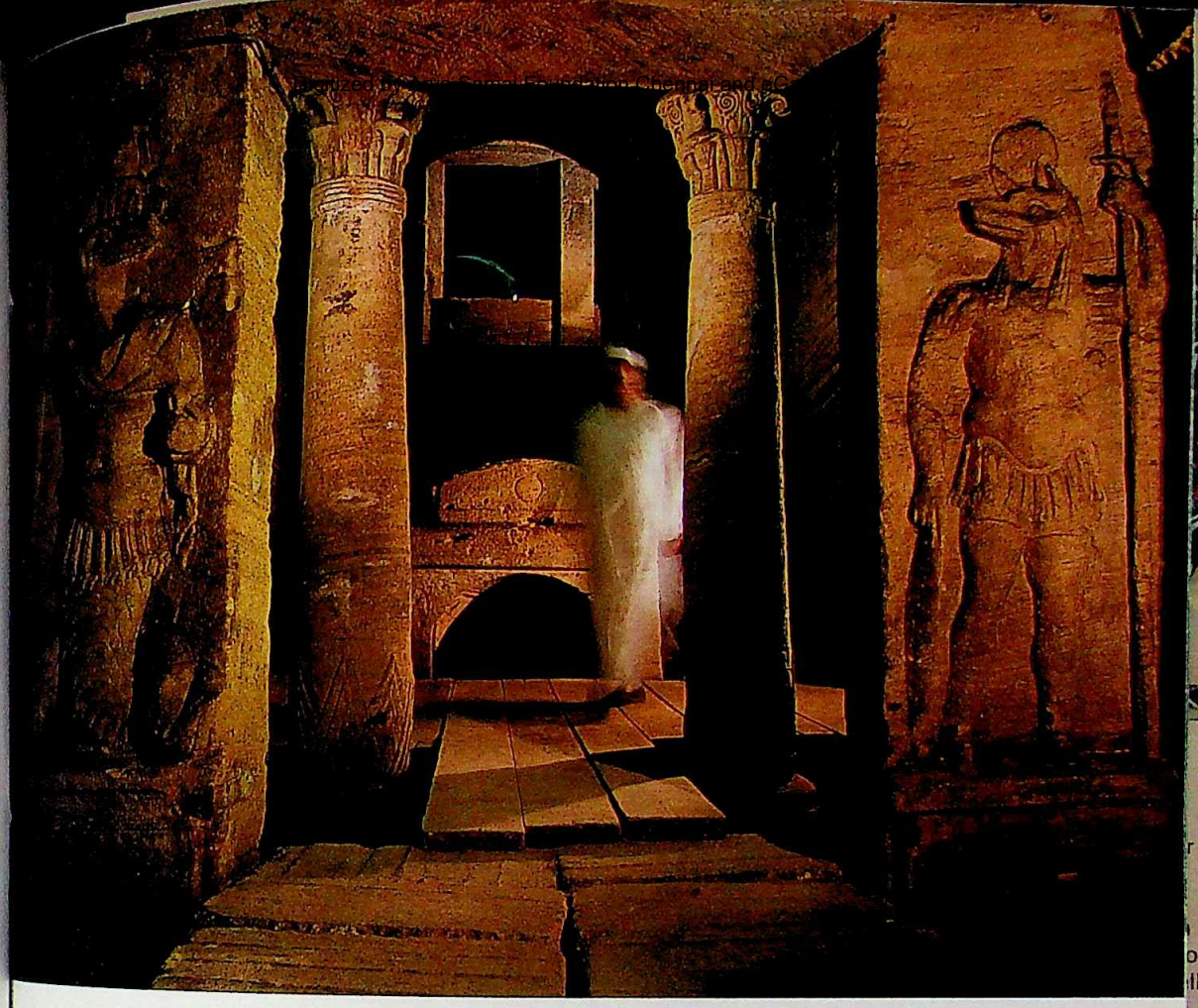

Far below the bustling streets of modern Alexandria, the catacombs of Kom el-Shoqafa unfold like a scroll revealing the city's hybrid past. Jackal-headed figures of Anubis, the Egyptian god of death, guard the main tomb armed as Roman soldiers. The wealthy family that built this vault around A.D. 100 filled it with Greek, Egyptian, and Roman motifs—as if hedging their bets with the gods.

by the construction of a pier, would offer an effective wave breaker.

The city grew steadily as a center for trade. About four decades after Alexander's death in 323 B.C. Ptolemy II built a lighthouse, known as one of the seven wonders of the ancient world. It rivaled the Pyramids in height at about 400 feet and had as many as 300 rooms. Fires, reflected in mirrors on top of the lighthouse, could be seen for some 35 miles, alerting ships to Egypt's reefs and shifting coastline.

In the 14th century it collapsed during an earthquake, and the Egyptians built a fortress here using, some accounts say, stones from the lighthouse. From my waterside café table I can see the fortress, where team members from the Alexandria-based Centre d'Études Alexandrines are easing into wet suits. They will dive down 20 feet, where they are cataloging statues, columns, and other architectural elements near the lighthouse site.

The past—and the answers it might hold—feels impossibly distant as I wander up the coast near where Cleopatra's palace once stood. Somewhere in this area, perhaps beneath my feet, lies the sarcophagus holding Alexander the Great. It disappeared from recorded history in the third century A.D. Also buried here in a site yet to be located is the famous Alexandria library, founded early in the third century B.C. as part of the Mouseion, the great research center of its day.

The idea of a library was not new. Egyptian papyrus libraries existed in 3200 B.C., and Athens had a library in the fourth century B.C. But Alexandria's library was on a scale new to the Mediterranean world, and the city was notorious for its aggressive pursuit of texts.

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The United Nations and other international agencies are cooperating with the Egyptian government to finance a new 200-million-dollar Alexandria Library near a possible site of the old one. Cranes swing steel beams overhead, and workers scamper up the scaffolding surrounding the building's circular framework.

Mohsen Zahran, the library's project manager, talks about reviving "the lighthouse of knowledge." The new library, he says, "will encourage peace and the exchange of ideas throughout the region and provide a place for scholars of diverse backgrounds to meet."

Little is known about how the ancient Mouseion operated because so few written records have been found. But we do know that it was a place for scholars to meet. From throughout their known world Alexandria's rulers invited nearly a hundred learned men to the Mouseion, where they lived in a communal residence and ate together in a dining hall. From these scholars came Euclidian geometry, the first scientific dissections of human bodies, a translation of the Hebrew Bible into Greek, and a compilation of Homer's epic poems.

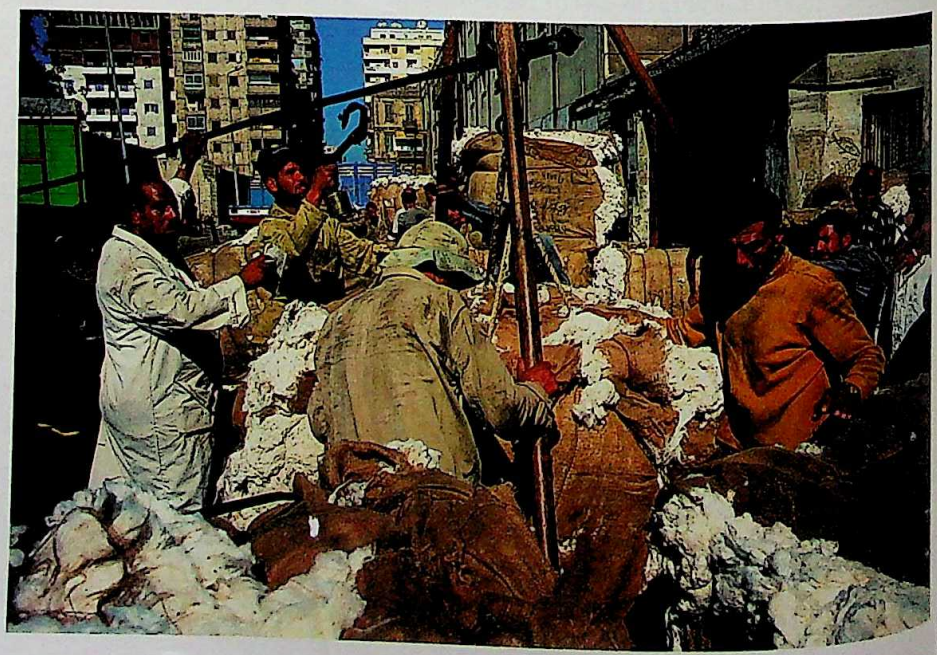
Scholarly pursuits had immediate commercial applications. Translations helped Alexandrians to better understand their trading partners, and new maps enabled traders to calculate distances more accurately.

Alexandria had hit upon a winning formula: Trade produces wealth, wealth pays for knowledge, and knowledge stimulates more trade.

Around 120 B.C. members of the Egyptian coast guard found an Indian sailor shipwrecked on the Red Sea. They took him to Ptolemy VII. The sailor spoke a language that no one in Alexandria knew, so Ptolemy treated the sailor like a book needing translation: He ordered that the sailor be taught Greek.

Thus educated, the sailor taught his captors something amazing: Monsoons over the Indian Ocean blow in a regular pattern—from northeast to southwest in winter and the opposite way in summer.

A significant part of Alexandria's trade took place with India and lands farther east that supplied the spices used for religious rituals, medicine, and preserving food. At the time, ships traveling from India



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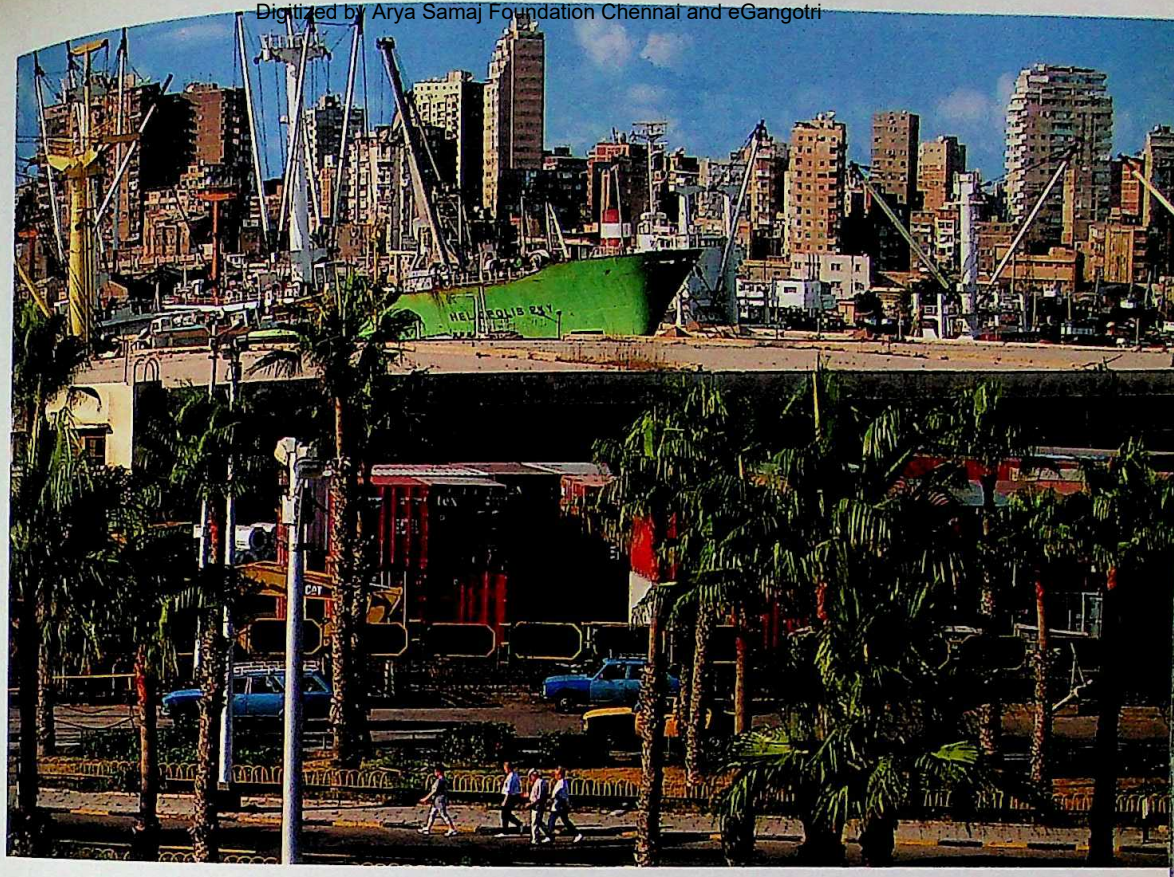

were sailed by Arabs and Indians who had mastered the monsoons. These sailors unloaded their ships at Eudaemon, Arabia (now Aden), and transferred goods to ships manned by Alexandrians sailing across the Red Sea to the coast of Egypt. Likewise, tools, iron, clothing, glassware, and linen from Alexandria were unloaded and reloaded on their way to India.

The stop in Arabia greatly increased shipping costs. The only alternative—transporting goods overland across the Hindu Kush, Persia, and Mesopotamia—was far more risky and expensive.

A trip to India with the shipwrecked sailor as pilot showed that the monsoon winds could facilitate a direct journey, and Alexandrians began to bypass the Arab middlemen.

THE STORY OF THE INDIAN SAILOR comes from the writings of Strabo. Such written sources provide most of our knowledge of ancient Alexandria, but much of it also comes from the kinds of artifacts that are being destroyed as the modern city grows. The foundations of Alexandria's new library are pounded into buildings dating from the second century B.C.

"Unfortunately, destroying ancient artifacts is the only way to build anything," an architect working on the new library explains to me. "The whole city sits on top of its ancient predecessors. If we are to make progress, to continue to grow, we can save only a little. The rest of what's down there must be left to our imaginations."

"What we do all over the city is largely rescue archaeology," Colin Clement, a researcher with the Centre d'Études Alexandrines, explains as we approach a necropolis where

(Continued on page 48)

When Alexander the Great founded Alexandria in 331 B.C., he chose the site for its potential as a port linking the Mediterranean and the Nile. Access to the flow of foreign trade and culture made Alexandria the crown of the Hellenistic world. Today a choked peninsula frames the city's Western Harbor (above), which handles most of Egypt's shipping. Cotton (facing page) is a prized export, much as papyrus was in Ptolemaic Egypt.

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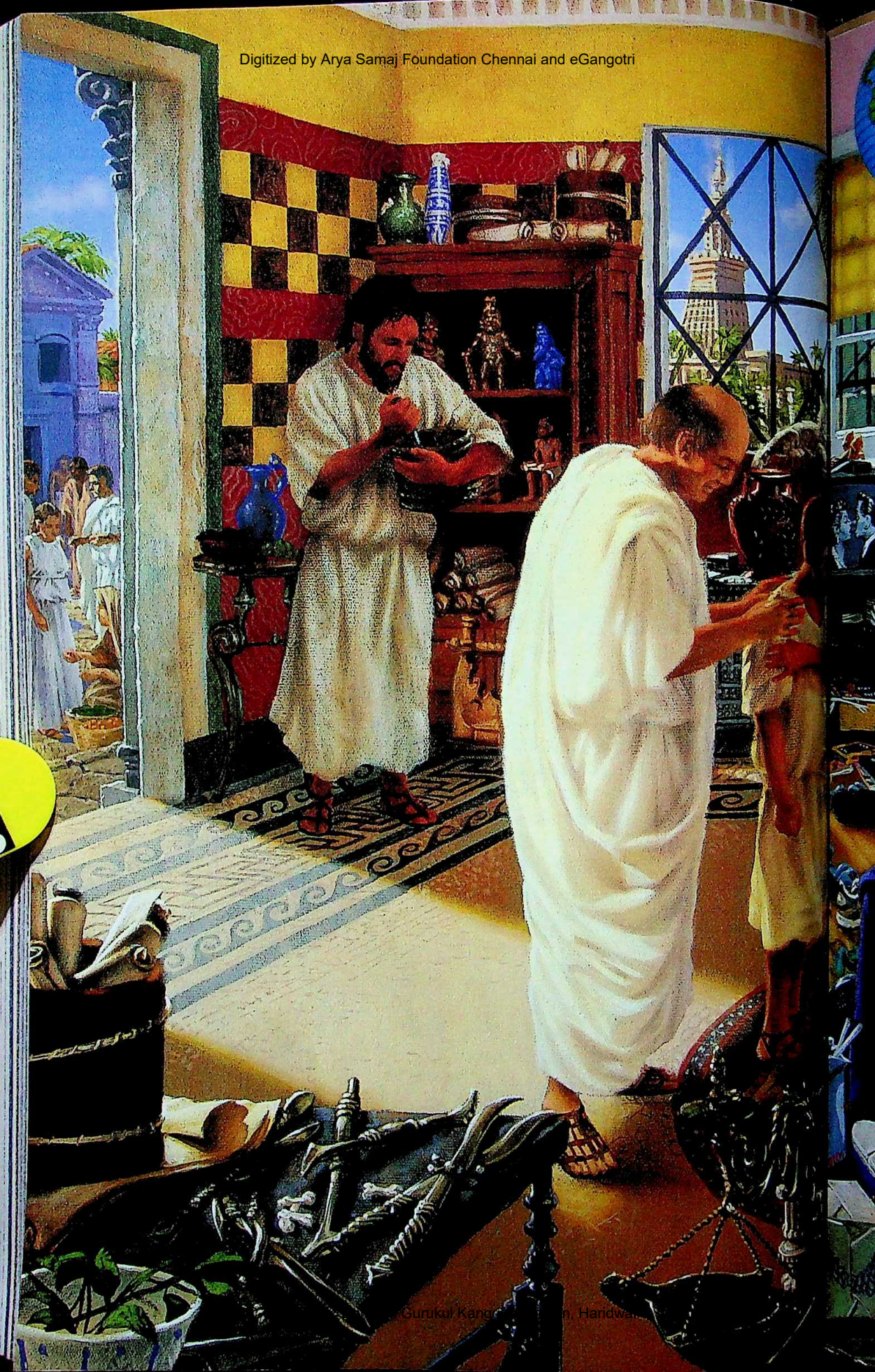

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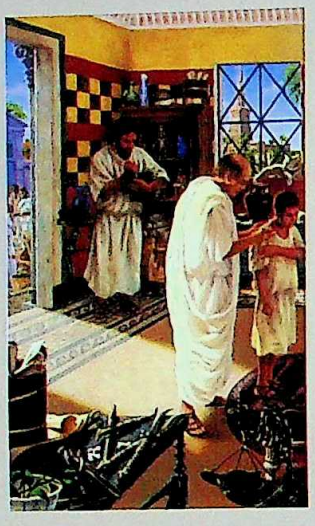
A Look at Life Through the Ages



A.D. 1
Alexandria, Egypt

Beyond the cosmopolitan clatter of an Alexandrian boulevard, a boy stands in his doctor's home awaiting a prognosis. On a table the latest medical tools, herbs, and scrolled treatises suggest reassuring competence. Roman furniture, shelved Egyptian idols, and Corinthian columns signal the multicultural mix of a city renowned for advances in geometry, astronomy, mathematics, and medicine.

To create this triptych of plausible scenes from the daily life of Alexandria in A.D. 1, Córdoba in 1000, and modern New York, artist René Milot consulted scholars and studied period objects. "Throughout history," he says, "we all need knowledge, music, food, interaction. We're all the same."

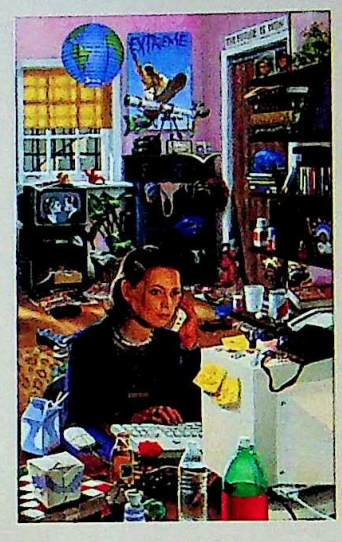
Likewise all cities share the hope of being immortal. Alexandria's massive lighthouse seemed a monument to invincibility. Yet after the Arabs established a new Egyptian capital, Alexandria faded into obscurity, and the lighthouse eventually tumbled into the sea.

A.D. 1000
Córdoba, Spain

Soothed by the sound of burbling water, two Cordoban children learn the Koran at the feet of a scholar. Perched on pillows of linen and silk, they may pause to sample dried figs, play a game of chess, or pluck the lute. Beyond their bloom-scented courtyard a minaret towers over a prosperous city of mosques, palaces, synagogues, and shops, the capital of western Islam.

Such was the life of well-to-do Cordobans in the late tenth century, the city's golden age. Conquered by Muslims in 711, the region blossomed because of advances in irrigation, introduction of grain and fruit crops, and patronage of art and science.

Literacy flourished as Córdoba became a center for translation of the religious, scientific, and philosophic works of antiquity. One Arab poet called the city "the garden of the fruits of ideas." Indeed, through Islamic Córdoba, scholarship passed into a backward Europe, forming a foundation for the Renaissance.



A.D. 2000
New York City

A young woman sits in her basement apartment, window barred against urban threats. When not out with friends, she is connected to the world via computer, cell phone, television, and radio—living life remotely, in a barrage of information. A caged iguana, dusty telescope, and potted plant hint at the natural world she has little time to enjoy. Cultural trinkets litter her room, disposable as a pizza box.

Craving stimulation, she wouldn't dream of living anywhere else. This "city of ambition," writes novelist Tom Wolfe, is "the irresistible destination of all those who insist on being *where things are happening.*"

Founded by the Dutch in 1653 and fueled by the creative energies of immigrants, New York is now a linchpin of global finance, culture, and trade—and a master of self-promotion. "I see New York as the center of the world," says Mayor Rudolph Giuliani. "It has a boundless future"—sentiments once shared, no doubt, by Córdoba and Alexandria.

For an interactive version of the artwork, visit *www.nationalgeographic.com/3cities.* Art by René Milot; consultants (above, from left) Marjorie Venit, Dede Fairchild-Ruggles, Bob Deutsch.

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SOUL OF A CITY Proud as an aged warrior, the ornate face of Córdoba's Mezquita hints at a life of past glory. Completed by the ruler al-Mansur in A.D. 994, this monument of marble and stone was western Islam's greatest mosque. Built on the site of a Christian

church, its history foretold its fate: Christians reconquered Córdoba in 1236. Perhaps swayed by the mosque's beauty (or carrying out a symbolic affront), they built a cathedral within its walls in 1523. Today, Roman Catholic prayers echo past the rich mosaics.

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Alexandrians buried their dead from the third century B.C. until the sixth century A.D. This necropolis covered more than a square mile.

We reach the excavation site, riddled with holes and piled with mounds of dirt. Overhead, a four-lane highway ends abruptly in mid-air. Streetlights line the sides of the road right up to the edge.

"Work on the highway stopped in 1997, when the Egyptian antiquities service realized the foundations were being driven into some pretty fantastic ruins," Clement says. "They asked us to take over work at the site. Our permit runs out next year."

Conducted down a 15-foot wood ladder, I am shown a room with red-and-yellow plaster friezes depicting dolphins and cupids—most likely a funerary chamber associated with a series of tombs.

In other rooms huge columns smash through the floors. "They'll support the finished highway when we're forced to end our work and leave," Clement explains after I've climbed back up.

We find a six-year-old boy with a group of men hauling dirt from an excavation. The child tells me that his nickname is Balaha—"date" in Arabic—because he loves to eat dates.

Clement tells me that after roadworkers realized they were opening old tombs, Balaha, who lived in a nearby shanty, showed archaeologists the necropolis's network of underground passageways. Balaha, who wears a torn baseball cap, ragged clothes, and rubber sandals, speaks with the poise of an adult as he describes how he stumbled upon an opening—presumably left by a long-gone grave robber—and began to play underground, telling no one. "I was never scared," he says.

I ask Balaha if he wants to be an archaeologist when he grows up.

"I already am," he replies.

From where I stand with Balaha, I can see freighters in Alexandria's harbor. That harbor, which now handles about 75 percent of the freight entering and leaving Egypt, has proved resilient. In the middle of the third century A.D. the city was torn by riots and religious conflicts: "Every street was polluted with blood, every building of strength converted into a citadel," wrote Edward Gibbon in *The Decline and Fall*

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Enticing as a bridal blush, the grounds at Córdoba's Fortress of the Christian Monarchs owe their enchantment to the Arabs. Using waterwheels and canals, these people of the desert turned Córdoba into a garden scented by citrus, jasmine, and other fragrant plants they introduced. At historic Plaza del Potro (facing page) an octagonal fountain evokes Islamic style—a stone oasis for weary souls.

of the Roman Empire. Earthquakes struck around A.D. 365. A plague wiped out much of the population in the late sixth century, and in the seventh century Muslims, less reliant than their predecessors on sea trade, conquered Egypt. Yet in A.D. 1000, more than 1,300 years after its founding, Alexandria was still an emporium of the world.

In A.D. 1 Alexandria's chief trading partner was Rome. By 1000 Rome had declined from the seat of a worldwide empire to a city of 35,000, and Alexandria was trading heavily with another power: Cordoban-controlled Spain.

CÓRDOBA, in the south-central Iberian Peninsula, had been a provincial capital under the Romans and was controlled by the Phoenicians before that. By A.D. 715 the Umayyads, a Muslim dynasty ruling from Damascus, had annexed most of the peninsula. Around mid-century a revolution destroyed the family and a surviving prince fled to Córdoba, where he proclaimed himself emir. The city grew, made wealthy by agriculture and mining in surrounding regions.

By the middle of the ninth century the city had running water, sewers, hospitals, paved and lit streets, promenades, gardens, and fountains. Contemporary observers described Córdoba's population as enjoying some 80,000 shops, 60,000 mansions, 1,600 mosques, 900 public baths, and 70 libraries. The craftsmen of Córdoba carved rock crystal and manufactured leather, paper, linen, and silk.

In the tenth century Córdoba's caliphs welcomed ambassadors from much of Europe and the Middle East. Scholars invented new surgical techniques and instruments, advanced understanding of medicinal

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herbs, accurately observed and measured celestial phenomena, and refined methods of irrigation, plant grafting, and crop rotation. Córdoba's merchant and naval fleet, based at the Mediterranean port of Almería, was among the largest in the world.

I make the overland trip between Almería and Córdoba with Jorge Lirola Delgado, professor of Arab and Islamic studies at the University of Almería. By car, on country roads, the 200-mile journey takes about six hours. In 1000, Lirola tells me, the transportation of goods between the two cities took seven days by foot or mule. Although the wheel had been in use for 4,000 years, the Muslim world had dropped it in favor of pack animals. A sea journey to Córdoba from points east was no simpler. It meant a passage out through the Strait of Gibraltar—difficult and potentially dangerous for vessels reliant on wind and oars—and then a trip up the Guadalquivir River from the Atlantic coast, stopping at Seville to transfer from seagoing ships to riverboats.

Córdoba, so inaccessible by water and far from international trade routes, seems an improbable site for such a large city. In fact, by the early 11th century Córdoba's heyday was passing. Alexandria, on the other hand, situated on a natural harbor, remained a center of trade for more than 2,000 years. Circumstances of geography contributed to Córdoba's eventual decline, but what other factors were at work?

THE MEZQUITA is the biggest single reminder of Arab civilization left in Córdoba today. Completed in the tenth century, the mosque—much of its interior since transformed into a cathedral—held 52,000 people. As I walk into the courtyard where Muslim worshipers once performed ritual cleansing, I reflect on the social structures in Córdoba and Alexandria.

Both possessed religiously and ethnically diverse populations that interacted in complicated ways. Greeks and later Romans in Alexandria and Muslims in Córdoba were the dominant groups and as such enjoyed legal, social, and economic privileges.

The Romans allowed the Jews but not the Egyptians in Alexandria to rule themselves. Roman citizens had the right to appeal legal cases to Rome, while others had to rely on local magistrates. Muslim Córdoba permitted Christians and Jews to enforce their own laws if they did not conflict with Islamic law. A Muslim man in Córdoba could marry a Christian woman, but only after she converted. If a Christian killed a Christian, the Christian community handled the case, but any crime involving a Muslim, whether as victim or accused, was tried in an Islamic court.

Christians eventually conquered Córdoba

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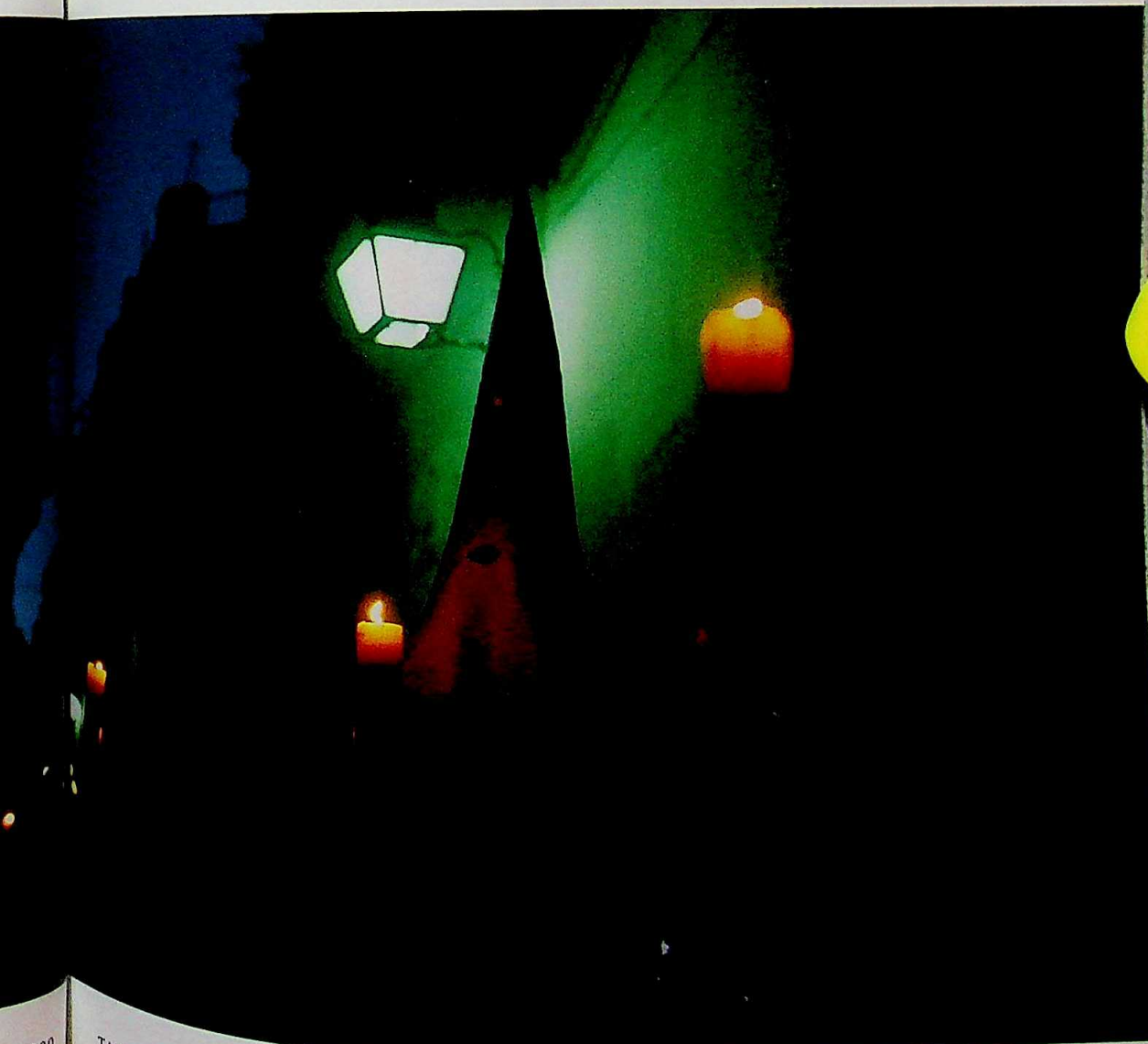
in 1236, but the city's decline came much earlier, at the Muslims' own hands. In the early 11th century, despite its prosperity, Córdoba experienced decades of conspiracy, assassination, slave revolt, and insurrection, in which thousands of people were slaughtered. Within two decades the once powerful caliphate disintegrated into more than 20 principalities.

I walk through Medina Azahara, site of one of the world's great palaces in the year 1000. Built five miles from the city by a caliph of Córdoba, the palace and grounds held more than 4,000 marble columns and, reportedly, mechanical birds and lions and shimmering pools of mercury. Hundreds of buildings sprawled over some 275 hillside acres.

A mob from Córdoba accompanied by Berber mercenaries demolished the palace around 1010, and soon Medina Azahara was abandoned. Stone floors, broken walls, and crumbling arches now stretch for hundreds of yards in all directions; more ruins lie buried under the green fields beyond. Pilfered pieces of marble columns and chunks of carved stone from the palace today adorn Córdoba's shops, restaurants, bank lobbies, and the patios of private homes.

Córdoba's decline as a major city was swift. Yet Córdoba endures.

Shrouded by the dominance of Catholicism, Córdoba's Islamic past is all but forgotten during Holy Week, when hooded penitents walk the streets in processions of contrition and hope. A thousand years ago Muslims tolerated—and also repressed—the sizable Christian minority. But by 1525 Cordobans had a stark new choice: Christianity or expulsion.



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WIRED AND RESTLESS Stars in a steel constellation, the towers of midtown Manhattan burn with a relentless energy that typifies New Yorkers themselves. Audacity began early on this island, the smallest of New York's five boroughs. In 1626 Dutch official Peter

Minuit "bought" Manhattan from resident Lenape Indians for the equivalent of $24. At that time it was an Eden of fertile hills. Transformed by money and engineering, it became one of the most densely populated places on Earth—the crown jewel of capitalism.

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At the Cubillas River on my way to the city, I crossed the Pinos Puente stone bridge. More than a thousand years ago caravans carrying leather and silk goods from Córdoba crossed the river at this exact spot. From local farmers I purchased olive oil; some of the trees that produce this oil, they told me, grew from cuttings taken from trees standing when the Muslims ruled Córdoba. Indeed, olive oil has always been a major export here. The Spanish call it *aceite,* derived from *zayt,* Arabic for olive oil.

Black pony, large moon,
and olives in my saddlebag.
Although I know the roads,
I will never reach Córdoba.

Federico García Lorca, a Spanish poet, sensing that past glory had made Córdoba an unattainable ideal, wrote these words in the early 20th century. Yet Córdoba *is* reachable—not the city once called "the mother of towns" but a thriving, and timeless, agricultural city of about 320,000 people. Fields of olive trees end where downtown department stores and office buildings begin. In cobblestone streets a millennium old, young couples walk arm in arm past sidewalk cafés.

Córdoba: once a powerhouse, undermined by its geographic location and political instability, now a small Spanish city supported by agriculture and steeped in romance.

As my plane floats over New York City, I look down at the empty berths of its harbor and wonder whether future generations will ever stroll around ruins in New York the way I strolled around the ruins of Medina Azahara.

Like Alexandria, New York was born beside a natural harbor. In 1950 the waterfront handled almost 20 percent of the nation's sea cargo, measured by weight. Today it handles less than 6 percent.

People, however, have always been New York's greatest import. Since 1860 between 20 and 50 percent of all New Yorkers have been foreign-born.

Easy-access jobs attract many immigrants to New York. So does the opportunity to make money. "The New York City economy is porous," says Mitchell Moss, director of New York University's Taub Urban Research Center. "There are many ways to enter. You wash dishes, then you own your own restaurant, then you manage the building." A large share of New York's immigrants, says Moss, are skilled and well educated. "No other city attracts the kinds of people who come here," he says. More than 700,000 of these new arrivals make Queens one of the most ethnically

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and racially diverse counties in the United States. Its public library, the country's busiest, loans material in 50 languages.

I'm standing on the sidewalk outside the Flushing branch of the Queens Library at 9:30 a.m., a half hour before the doors open. More than a dozen people are here, waiting to go in. By 10:30 the library resembles a busy supermarket, with clerks shouting "Next, please" to people lined up to check out books.

An English conversation group is meeting on the lower level, and I sit in for a while. Some of the students describe New York as a school, where they learn about survival in America. "If I can make it there, I'll make it anywhere," says one, quoting a 1977 show tune.

Most of the people in the group are immersed in the city. One describes a matinee performance of Bizet's *Carmen;* another recounts a recent visit to Rockefeller Center. The daughter of a third has just completed a recital at the Juilliard School.

I join an English language class in another room, where I sit between an opera singer from Shanghai and a botanist from Uzbekistan.

Yuzef Murdakhayev, the botanist, invites me home for lunch. His wife, Margarita, brings out apricots, almonds, pistachios, chickpeas,

"Taxi!" Hailed as icons of New York, yellow cabs haul a million people a day in this city of 7.5 million. "What New York did . . . with congestion was to make an art of it," wrote architecture historian Douglas Haskell. The first U.S. city with an elevated railway and an under-river tunnel for cars, New York became a theater for the art of urban movement.

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Art reflects life at the Marian Goodman Gallery, where a tiny boy flips for sculptor Juan Muñoz's "Towards the Mirror." "New York is a city that enables the arts to flourish," says Goodman. "There is respect for the creative process here."

There's an equal respect for space. A fashion showroom doubles as a party venue (facing page) in the garment district, where yesterday's sweatshops are today's boutiques.

and dumplings. Yuzef, who speaks Russian, Persian, and Turkish, has written three books and about 300 scholarly articles. Books fill one wall of his living room. "Why bring clothes?" Yuzef says. "I brought books."

Unable to find work as a botanist because he does not yet speak English well, Yuzef helps his two sons with their jewelry manufacturing business. Two of his grandchildren, born in New York, are American citizens, and the rest of the family expects to gain citizenship soon.

After lunch Yuzef walks me to the subway. Emerging 40 minutes later from Grand Central Terminal, I am immediately struck by the energy, the anything-is-possible attitude, that makes Manhattan unique. It comes from the concentration of people, the sky-scraping architecture, and from money, Manhattan's main import. Trillions of dollars move through the city each day.

BILLIONS OF DOLLARS PASS ANNUALLY over the desk of Dan Stern, a 37-year-old investment banker. He has lived in New York since graduating from business school in the late 1980s. Stern's corner office on the 43rd floor of a midtown office building has a view of Central Park. In addition to a desk and credenza, it has an easy chair and sofa for visitors, a small tree, and a table holding an orchid in full bloom. A chalkboard covers an entire wall—Stern uses it for financial calculations.

Most of the day Stern stands in front of his computer screen, talking on the telephone about deals and potential deals, including the purchase and sale of hotels, factories, and publishing ventures. He occasionally checks e-mail or an online stock quotation or asks his assistant to send documents via fax or overnight delivery.

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Despite the money involved—30 million dollars for a "small" deal—Stern is relaxed and soft-spoken. "Putting together a profitable venture is like making a movie," he tells me. "You have to balance ideas, capital, and talent. Your judgment about people has to be good."

Of a potential partner in an overseas venture, Stern tells an associate, "I know him. He has good intentions. We can trust him."

Most people Stern calls, or whose calls he accepts, are people he already knows or people who know people he knows. "I wouldn't have spoken to him unless he was a friend of someone I trusted," he tells me after one conversation that could affect the operation of a major international hotel chain.

Stern is in New York, he says, for the stimulation and the competition. "This is the big leagues," he explains. "If you want to play in the majors, you have to be here."

Although he'll soon fly to Japan to examine possible investments, Stern doesn't travel much. People he needs to meet in person, the Chinese business executive who has stopped here on his way between New Zealand and Switzerland, for example, always seem to come to New York.

Dan Stern's world is electro-personal. With telephone, e-mail, fax, and computer, he can communicate all over the globe. But at every step a personal relationship or face-to-face contact is crucial.

This electronic dealing characterizes knowledge-based industries, like finance, corporate management, and advertising, which now produce almost a third of the private-sector jobs in New York City.

DoubleClick, an Internet advertising company, was started in Atlanta in 1995 and moved to New York the next year. The company places 200 million website advertisements a day, reaching 40 million people each month.

"We could be anywhere," says Kevin O'Connor, the co-founder and chief executive officer. "We're in New York because a Madison Avenue address gives us instant credibility, especially overseas."

DoubleClick is hiring people at the rate of one a day and will soon

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CIRCLE OF LIFE Hidden in the wings, dancer Michael Joy prepares to swoop onstage to portray a flock of birds in *The Lion King*—a musical that is "visually and physically breathtaking," says Joy. It plays in Broadway's New Amsterdam Theatre, whose recent

restoration by the Walt Disney Company has helped ignite a revival of the once seedy theater district. "When people experience live performance, a theater can become a sacred space," says *Lion King* director Julie Taymor. "In its realm your spirit is touched."

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Theater of the absurd, Times Square offers a tableau of people, pop culture, and philosophic angst. New York is a city of strangers, wrote essayist E. B. White, "seeking sanctuary or fulfillment or some greater or lesser grail." Perhaps the role of all great cities is to serve as crucibles for evolving human identity.

have a thousand employees. It's a 24/7 company—open all the time.

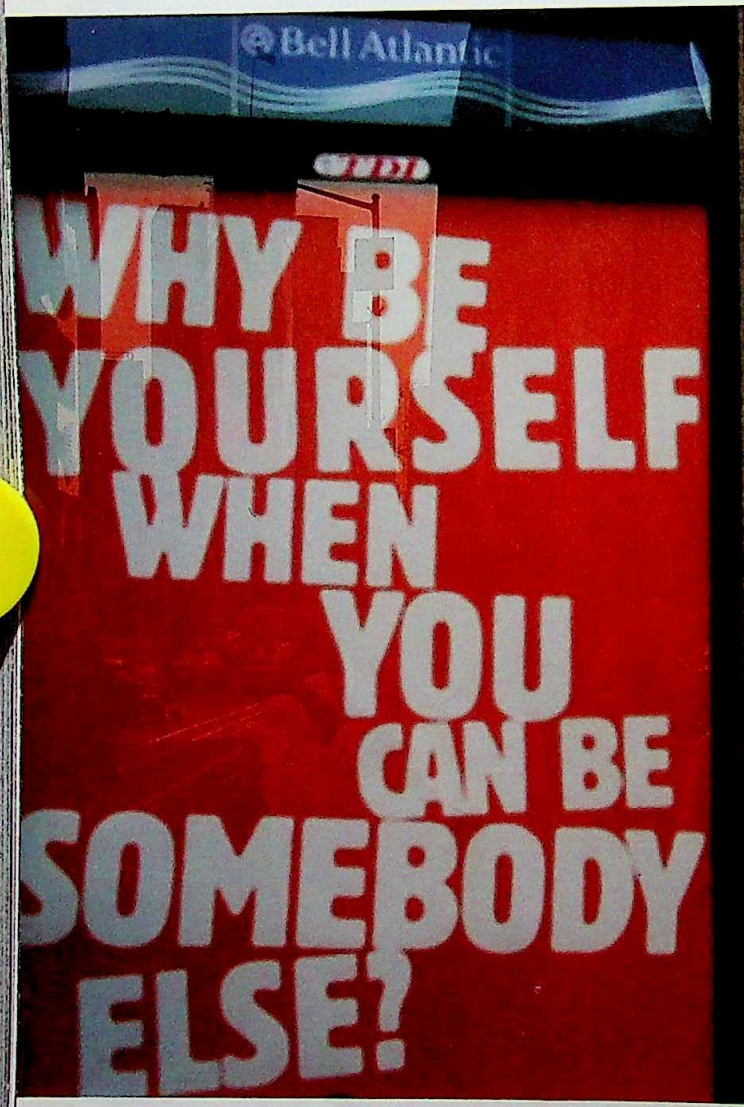
At 2 a.m. I chat with the four DoubleClick employees on duty. Two are from China, one is from Ukraine, and one has a father from Hong Kong and a mother from Burma.

Victor Ng is 21 years old and studies computer science full-time at a local college. "Do you do schoolwork during slow periods between phone calls and e-mails?" I ask.

"I don't have time," he says, pointing toward five books on network operations and problem solving. "I read those. I have to keep up with practical applications."

Victor doesn't have time to study for school because he is studying for work. He seems to be a living manifestation of the winning formula I'd discovered in Alexandria, Egypt: Trade produces wealth, wealth pays for knowledge, and knowledge stimulates more trade. What Victor learns produces more business for DoubleClick. With increased profits DoubleClick pays for more knowledgeable employees. Knowledgeable employees bring more business.

The next morning I wander south from DoubleClick toward the Union Square area, which was full of small factories at the beginning



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of the 20th century—when manufacturing was the single most important source of jobs in New York. The buildings, many of which housed artists' studios in the 1960s, are now stores, offices, and restaurants.

School buses wrapped around the block in front of a former glove-and-belt factory prompt me to go inside. Ballet Tech now occupies the top two floors. Under exposed pipe and pressed-tin ceilings are classrooms and mirrored dance studios.

Twenty years ago Eliot Feld, who had danced with the New York City Ballet at age 11 and in 1969 formed his own dance company, was wondering where to find young dancers. Watching public schoolchildren on a subway, he realized they were an untapped pool of talent, and Ballet Tech was born.

More than 800 young students, selected from the 30,000 who audition each year, arrive by bus several times a week from throughout the city. After the fifth grade another selection process narrows the student body to 60, who attend middle and high school full-time at Ballet Tech. Of these, fewer than a dozen eventually join Feld's professional company.

"Dance training should not be wed to our notion of classic ballet, which is essentially a 19th-century idea of what ballet should be," Feld tells me. "Dance should capture what you feel when you walk the streets of New York. It should challenge accepted wisdom, weave in the new, allow change and growth. Art is always an argument with the past."

I watch a rehearsal. Nine girls, ages 12 to 14, have been dancing for an hour and a half and have two more to go.

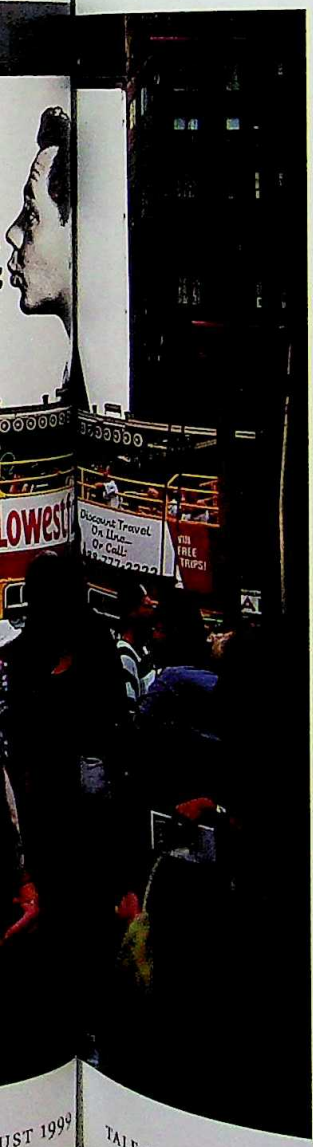
Feld demonstrates steps as he choreographs a dance. "Show me your soul, ladies," he pleads. They try the new steps. "Come on, a little more stately," he shouts. A moment later: "You need fewer bones in your arms. Dance more like a squid. You must not show me any edges. There are no edges."

The girls glide past again. "No, no, no!" Feld shouts, on his feet. "You started to feel it, and then you lost it!"

They return to the far corner of the room and dance toward him again. "Nice, ladies! Nice, ladies! Getting there."

Watching Feld, I realize I'm witnessing the essence of the three cities—and the two millennia—that I've visited: human interaction fueling challenges to the known and a desire to create something better.

Ballet slippers are still slapping the hardwood floor as I leave. Subway sounds drift in a window. Joining the crowds rushing along the sidewalk, I keep hearing Feld. "You can't only do what's possible," he told his young dancers. "You *change* what's possible." □



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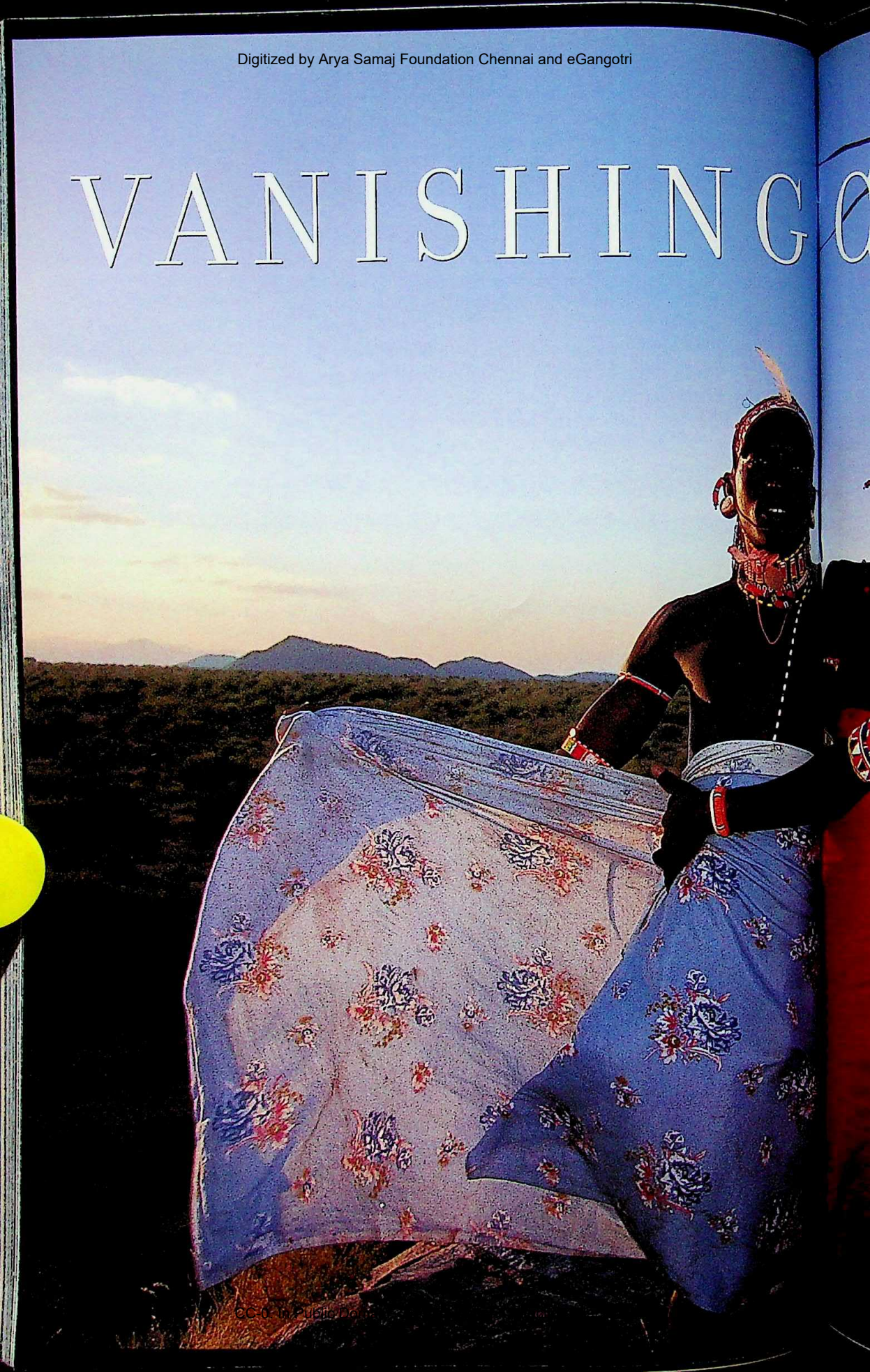
VANISHING



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CULTURES

Around the world it's the same story but with different faces: age-old cultures besieged by modern pressures. The faces here are drawn from three distinct peoples on three different continents. In Kenya, Ariaal warriors (left) cling to a nomadic existence. Borneo's Penan face destruction of their rain forest home. And in the high desert of Bolivia the Chipaya persevere in an all but barren land.

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The issue is whether ancient cultures will be free to change on their own terms.

By WADE DAVIS
Photographs by MARIA STENZEL

AMONG THE KOGI INDIANS of northern Colombia, a child of four is taken from his family and carried high into the Sierra Nevada to be trained for the priesthood. For the next 18 years he will be a stranger to the sunlight, sequestered in stone huts for two nine-year periods deliberately chosen to mirror the nine months spent in his natural mother's womb. Now in the womb of the divine Mother, he will know only darkness and shadows and thus acquire the gift of visions, becoming capable of seeing not only into the future and past but also through every material illusion of the universe.

Finally, after years of study and rigorous practice, the great moment of revelation arrives. On a clear morning, with the sun rising over the flank of the mountains, the initiate is led into the light of dawn. Until then the world has existed mainly as a thought. Now for the first time he sees the world as it is, the transcendent beauty of the Earth. In an instant everything he has learned is affirmed. Standing at his side, the elder who has trained him sweeps an arm across the horizon as if to say, "You see, it is as I told you."

This tradition is but one example of the infinite range of the human imagination brought into being by culture. In Haiti a voodoo priestess responds to the rhythm of drums and, taken by the spirit, handles burning embers with impunity. In the Amazon lowlands a Waorani hunter detects the scent of animal urine at 40 paces and identifies the species that deposited it in the rain forest. A Mazatec farmer in Mexico communicates in whistles, mimicking the intonation of his language, sending complex messages to other Mazatec across the broad valleys of his mountain homeland. It is a vocabulary based on the wind.

Just to know that such peoples exist, that jaguar shaman yet journey beyond the Milky Way, that the myths of Athapaskan elders still resonate with meaning, is to remember that our own world does not exist in some absolute sense but rather is one model of reality. The nomadic Penan in the forests of Borneo, the Ariaal herders in the deserts of Kenya, the Chipaya farmers scratching a living from the tired soils of Bolivia reveal that there are other possibilities, other ways of thinking and living with the Earth.

Worldwide some 300 million people, roughly 5 percent of the global population, still retain a strong identity as members of an indigenous culture, rooted in history and language and attached by myth and memory to a particular place. Yet increasingly their unique visions of life are being lost in a whirlwind of change.

In Brazil a gold rush brings disease to the Yanomami, killing a quarter of the population in a decade, leaving many of the 8,500 survivors hungry and destitute. In Nigeria pollutants from the oil industry saturate the delta of the Niger River, homeland of the Ogoni, impoverishing the once

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fertile soils. In Tibet 6,000 monuments and monasteries, ancient temples of wisdom and veneration, are reduced to riprap by the Chinese. And in the forests of the Congo sexually transmitted diseases and other illnesses from the outside are ravaging the Efe Pygmies.

These are not isolated events but rather elements of a global phenomenon that will no doubt be remembered as one of the hallmarks of this century. There is no better measure of this crisis than the loss of languages. Throughout all of history something on the order of 10,000 spoken languages have existed. Today, of the roughly 6,000 languages still spoken, many are not being taught to children—effectively they are already dead—and only 300 are spoken by more than a million people. In another century fully half of the languages spoken around the world today may be lost.

More than a cluster of words or a set of grammatical rules, a language is a flash of the human spirit by which the soul of a culture reaches into the material world. "A language," says Michael Krauss of the University of Alaska, "is as divine and mysterious as a living organism. Should we mourn the loss of a language less than the loss of a species?"

The biological analogy is apropos. Extinction when balanced by the birth of new species is a normal phenomenon. But the current wave of species loss caused by human activities has no precedent. By the same token, languages, like cultures and species, have always evolved, but today languages are being lost at an alarming rate—within a generation or two.

"When we lose a language, it is like dropping a bomb on the Louvre," laments Ken Hale of the Massachusetts Institute of Technology. As languages disappear, cultures die. The world becomes inherently a less interesting place, but we also sacrifice raw knowledge, the intellectual achievements of millennia.

The issue is whether ancient cultures will be free to change on their own terms, adopting beneficial aspects of the modern world while rejecting intrusions that can only harm their spirit and heritage. With this question in mind I made two journeys, accompanied by Maria Stenzel, my photographic colleague: one to the rain forests of Borneo, home to some of the last nomads of Southeast Asia, and the other to the deserts of East Africa, long inhabited by wandering herdsmen, among them the Ariaal and the Rendille.

THE BARAM RIVER is the color of earth. To the north the soils of Sarawak disappear into the South China Sea, and fleets of Japanese freighters hang on the horizon, awaiting the tides and a chance to fill their holds with raw logs from the forests of Borneo. A hundred miles upriver, on the banks of the Tutoh at the Penan settlement of Long Iman, my old friend Mutang is away hunting wild pigs, to be sold to loggers in a nearby camp. His father, Tu'o, headman of the longhouse, was born in the forest, at a time when nearly all Penan were hunters and gatherers.

But all of Mutang's life has been marked by the frenzy of logging that has gripped Malaysia over the past three decades. The country accounts for 33 percent of world tropical timber exports, with most logs coming from the states of Sabah and Sarawak. As the trees fall, the Penan, deprived of their traditional basis for life, drift toward government settlements, built with the intent of drawing the people out of the forests. As a result no more than 300 of the roughly 7,000 Penan are today nomadic.

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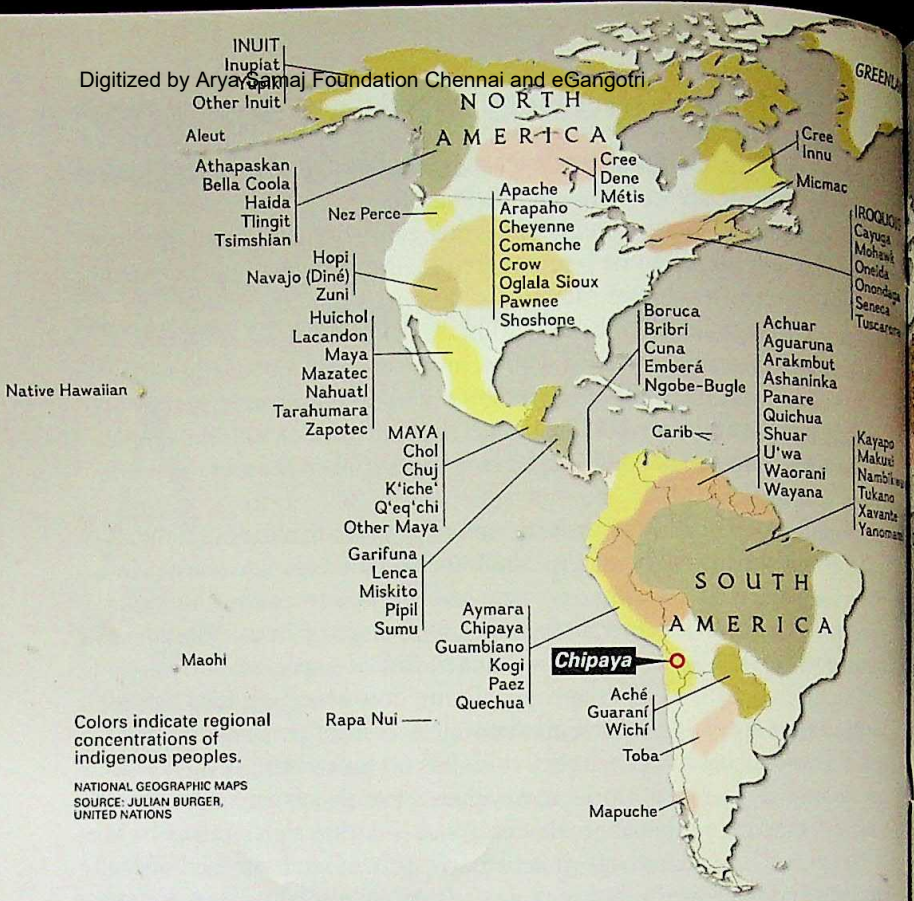

Requiem or Reprieve?

There are at least 5,000 indigenous cultures worldwide, and the map above only hints at their diversity. Though marginalized in most societies, these peoples have survived. Says Julian Burger of the UN's Office of the High Commissioner for Human Rights, "All over the world indigenous peoples are asserting their cultural identity, claiming their right to control their futures, and struggling to regain their ancestral lands."

Long Iman is bleak, a wooden longhouse roofed in zinc, with great empty rooms and shuttered windows that keep out the wind. The river is soiled with silt and debris, the water no longer fit to drink. The afternoon rains turn the clearings around the settlement to a mud mire where children play. When Maria and I meet Tu'o on the landing by the river, he greets us warmly, touching our hands in turn and passing his fingers over his heart. I don't mention his name, and he says nothing of mine. We call each other *padéé,* brother, the proper salutation.

In the evening children gather around a television and watch as a Malaysian journalist reads the news in a language few of them understand. Tu'o apologizes for the spartan fare at dinner: rice and broth, a plate of wild ferns. "How can you feed your guests in a settlement? It's not like the forest, where there is plenty of food. In the forest I can give you as much as you want. Here you just sit and stare at your guests, and you can't offer them anything. This longhouse is well built, and we have mattresses and pillows. But you can't eat a pillow."

Thirty years ago government agents induced Tu'o to settle at Long Iman. Facilities that were promised—schools and clinics—were never built. There are few jobs, mostly menial work in logging camps, and with little experience the Penan make poor farmers. For Tu'o recalling the past is not a matter of mere nostalgia. It is a longing for a time when his children didn't have to go to sleep hungry and the people lived by the grace of the forest, unaware of the impending cataclysm.

WADE DAVIS holds a Ph.D. in ethnobotany from Harvard University and has written extensively on subjects ranging from Haitian voodoo and Amazonian myth to the global biodiversity crisis. This is his first article for the magazine. MARIA STENZEL is a frequent contributor who photographed one of the last nomadic bands of Nenets reindeer herders in Siberia for the March 1998 issue.

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I explain to Tu'o the purpose of our journey: To reach one of the last bands of nomads, a cluster of families from the Ubong River who live for the most part in the remote reaches of Gunung Mulu National Park, a mountainous refuge that rises from the Tutoh River. Only in the confines of the park is the forest pristine and the traditional subsistence base intact. With us is Ian Mackenzie, a Canadian linguist intent on compiling the first Penan grammar and dictionary. It is a labor of years. This is Ian's tenth sojourn among the Penan, my third visit.

Asked to form an expedition overnight, Tu'o is ready by dawn. With six young Penan as our companions and Tu'o as guide, we leave Long Iman traveling up the Tutoh by longboat to reach a trail that climbs steeply through gingers and wild durian. Movement toward the ridge is slow and deliberate. For the Penan, even those recently settled, the destination is everywhere and nowhere. The capacity for survival lies all around in the forest.

Approaching the ridgeline, two hours above the Tutoh, we hear the low drone of logging trucks downshifting on the far side of the river. Peering through an opening in the trees across the narrow valley, Yapun, one of the young Penan, says with obvious contempt, "That is the work of Taib." Having denounced Abdul Taib Mahmud, the government minister responsible for Sarawak's forestry practices, Yapun turns his attention to a parade of insects at his feet. "If only we were as plentiful as these ants, the Malaysians would leave us alone. But it is they who outnumber the ants and make our lives so miserable."

For two long days we walk farther into the forest, following a route that rises and falls with each successive ridge. Delighted to be away from the settlement, the Penan watch the forest for signs, hunting hornbills at dusk, tracking deer and sun bears, gathering the ripe fruits

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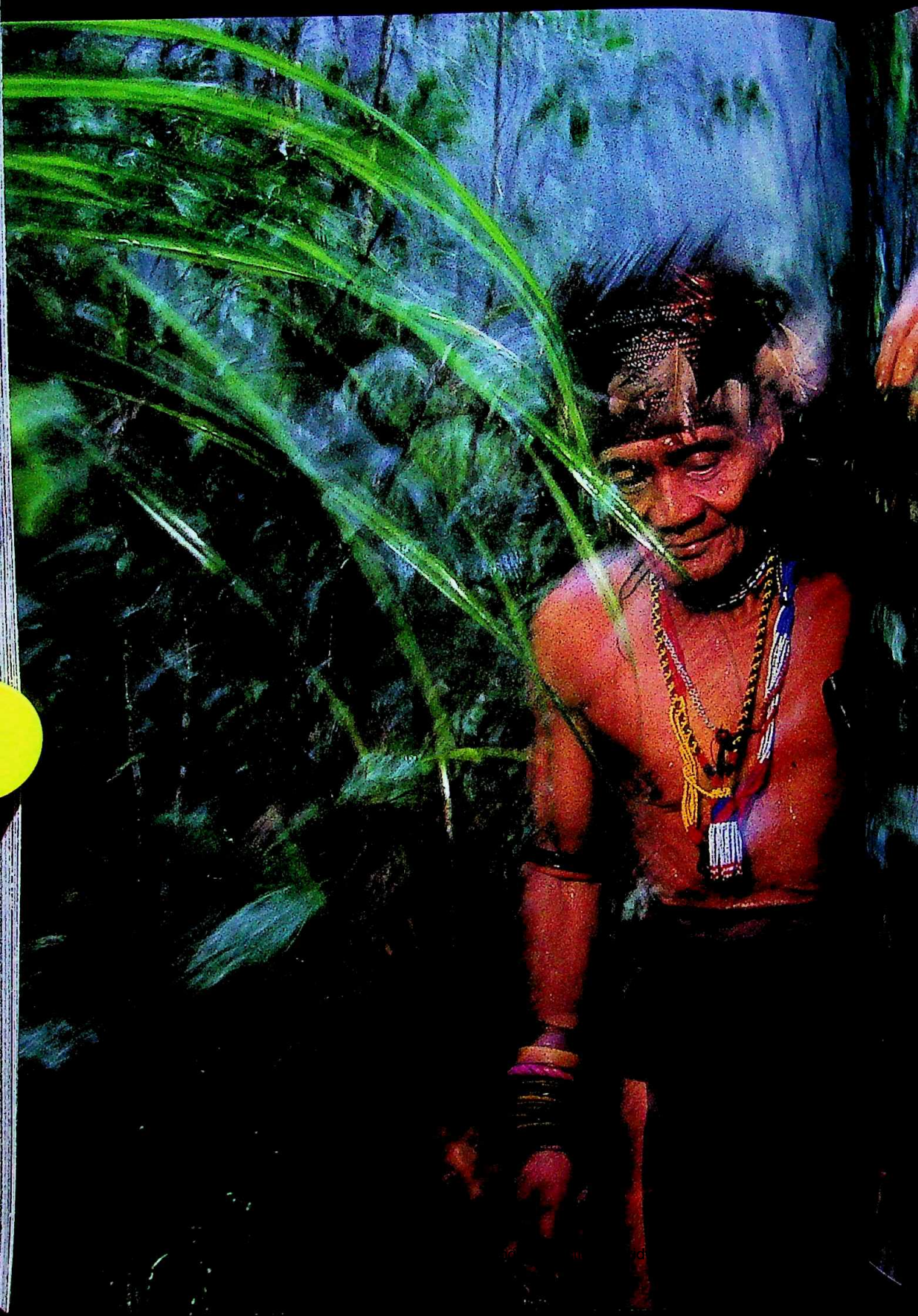

SHOULDERING HIS BURDEN, Lakei Padeng gathers poles to build a shelter deep in Gunung Mulu National Park, a protected swath of rain forest in the Malaysian state of Sarawak on the island of Borneo. Of the some 7,000 people of the Penan tribe, Lakei Padeng decade forcing

Padeng is one of 300 or fewer who still live in the rain forest. As for the rest, three decades of government-sanctioned logging has nearly destroyed their homeland, forcing them to live in dreary resettlement camps—an even heavier burden to bear.

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of mango trees. On the third morning our party crests a steep hill; we have reached the nomads. It is just after dawn, and the sound of gibbons howling runs across the canopy. Smoke from cooking fires mingles with the cool mist. A hunting party returns. Tu'o bows his head in morning prayer. "Thank you for the sun rising, for the trees and the forest of abundance, the trees that were not made by man, but by you."

On this ridge at Lamin Sapé, where generations of Penan have come, four families remain, in flimsy thatch shelters made of poles and rattan perched above the forest. Asik is the headman. Ten years ago I met him on the banks of the Tutoh, when the river ran clear. He had recently been jailed for participating in blockades that had shut down logging in much of Sarawak. Begun as a quixotic gesture, blowpipes confronting bulldozers, the protests electrified the international environmental movement, leading then Senator Al Gore to describe the Penan as the frontline troops in the battle to save the Earth. But the logging continued.

"From the time of our origins," Asik laments, "we have preserved the trees and animals, every single thing in the forest. This we know. It is in our legends, our traditions. When we think of the places and our land, our hearts are troubled. Everywhere I go, I feel the need to weep."

For the Penan the destruction of their forests represents far more than the loss of subsistence: It implies the death of a people. The forest is their homeland, and all their history is recorded in landscape. Peter Brosius, an anthropologist at the University of Georgia, lived among the Penan for nearly four years. "The land," he says, "is filled with cultural significance. For streams alone they have over 2,000 names, each imbued with its own history. Bulldozers and roads obliterate recognizable features. Once the canopy is opened, an impenetrable mass of thorny underbrush makes access and movement impossible. The cultural resonance of the landscape, all the sites with biographical, social, and historical significance, are hidden, producing a sort of collective amnesia."

IN THE MORNING we go with the children to gather fruit in the forest. Pajak, the eldest of the nomads, who vows never to enter a settlement, sends with us two of his daughters, Tudé and Lesevet. The wild tangle of trails and vegetation would lose us in a moment were we not able to follow the nimble steps of girls not yet a decade old. They skip across ravines, slip past thorn palms, squeal with delight as they climb, hand over hand, up lianas that lead to branches of white *langsat* fruits, sweet as nectar, which, shaken from the limb, are gathered and carried back to camp in baskets woven from rattan.

Asik is there to meet us, and we follow him and his wife, Juna, down a steep and slippery slope to a glade in the forest where water runs. With him is his son Péndi, a toddler of two, scampering alongside a pet monkey, a pigtailed macaque that strikes away at every opportunity. "Come back, my friend," Asik cries, "I will protect you." The monkey returns and leaps onto his shoulder. Though content to kill most anything in the wild, the Penan never harm an animal once it has been brought into the circle of the family. Nothing horrifies them more than the thought of raising domesticated animals for slaughter.

Along the trail Asik points out leaves that heal, others that kill, and magical herbs believed to empower hunting dogs and dispel the forces of darkness. There are trees that produce rare resins and gums for trade with traveling merchants, vines that yield twine and fiber for baskets,

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Boredom consumes young and old at Long Iman, a resettlement camp built on the banks of Sarawak's Tutoh River amid government promises of economic development. After more than 30 years the villagers are still waiting for a school to be built. Children, meanwhile, play in squalor and go to bed hungry.

a liana that smolders for days and allows for the transport of fire.

The most important plant of all is the sago palm, the tree of life. Already that morning Asik has cut down a stand. Now, on a bed of fresh leaves, he splits the sections of trunks in half lengthwise and with a slow steady rhythm pounds the soft pith. Leached with water, the pith yields a thick paste, which is dried into sago flour, the main staple of the nomads. In an afternoon Asik and Juna secure enough food for a week.

Two nights later, close to dusk, with thunder over the valley and the canopy of the forest alive with the electrifying roar of black cicadas, we sit by a fire as Tu'o cooks the head of a small deer. Everything one hears, he explains, is an element of a language of the spirit. Thunder is the embodiment of *balei ja'au*, the most powerful magic in the woods. Trees bloom when they sense the song of the peacock pheasant. Bird-calls heard from a certain direction bear good tidings; the same sounds heard from a different direction are a harbinger of ill. Entire hunting parties can be turned back by the call of a banded kingfisher, the cry of a bat hawk.

Asik emerges from the forest, his face scratched and bleeding from an encounter with a thorny vine as he hunted monitor lizards. Tu'o laughs as Asik recounts his folly, a whole day on the trail and nothing to show for it. Asik's nephew Gemuk appears. Stunned to find us in his home, he pours a basket of rambutan fruits at our feet, fruit that had taken hours to gather. Other Penan return with baskets of *buaa nakan* fruits to roast, wild mushrooms for soup, hearts of palm, and succulent greens. When Gemuk announces that not one but two wild pigs have been killed, Asik roars with delight. "Don't be hungry. Good to be full."

Moments later there is a shout from the ridge. Two other families have

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TO GET FLOUR FROM THE RAIN FOREST, Asik, headman of a band of Penan nomads, tramples pulp from the sago palm as his wife adds water. Strained through a rattan mat, the pasty starch is collected and dried into powder. The nomads' staple food,

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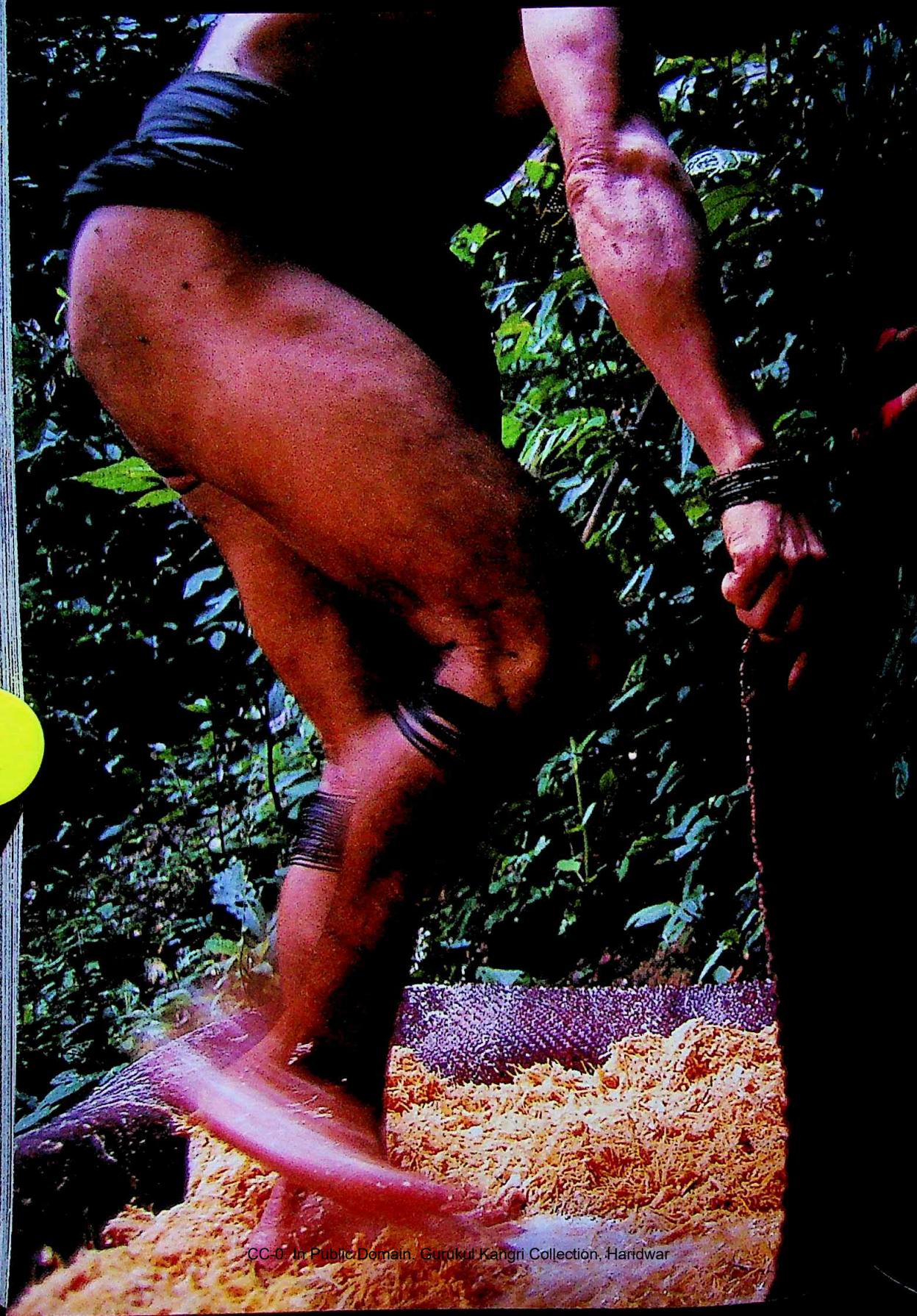

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sago is plentiful in Gunung Mulu National Park. Elsewhere in the forest, loggers plow down the palms to get at larger timber. The resulting underbrush—tangled and overgrown from direct sunlight—makes the remaining palms often difficult to reach.

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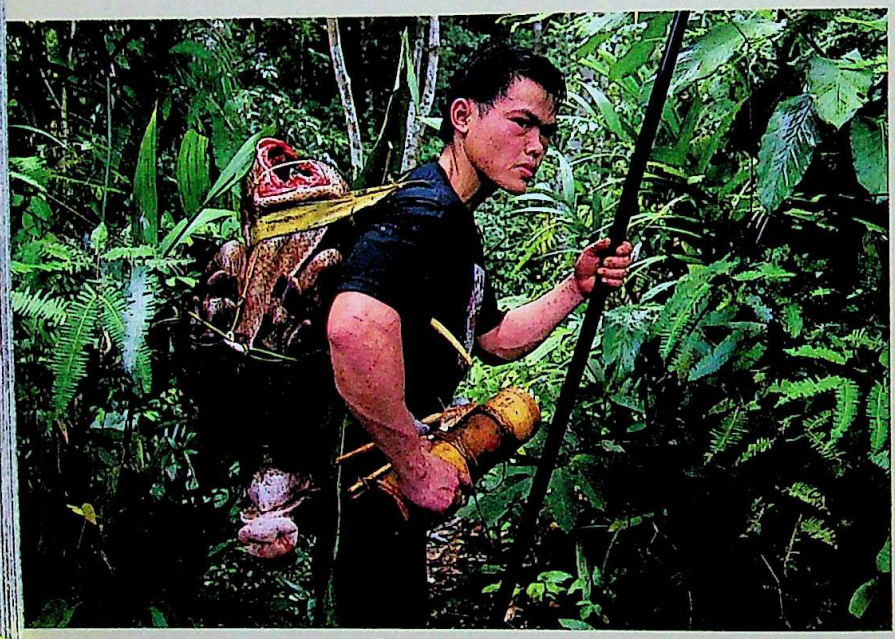
BLOWPIPE HANDY JUST IN CASE, a hunter (below) returns to camp after taking down a *babui*, or bearded pig, with a rifle. The main source of meat for Penan nomads, pigs have become less plentiful as loggers raze fruit trees where the animals forage. After Asik erects a shelter from saplings, palm fronds, and rattan (bottom right), the group's children prepare the pig's head for cooking (right). Practicing the Penan tradition of sharing, a girl distributes a handful of sweet *langsat* fruit (bottom). "They're losing that tradition in the settlements," says photographer Maria Stenzel. "There's never enough food to go around."



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arrived just as a tremendous rainstorm cracks open the sky. In the midst of the downpour they erect *lamin*, shelters built in an hour that will house them for a month. The men and boys cut poles and rattan to build the frame; the women gather palm leaves to be sewn into thatch. A fire is kindled. Infants huddle beneath leaves while older children assist their parents. Lakei Padeng is Asik's stepfather, an old man known as "black face." I watch as he empties the rattan backpacks. Two families—five adults, eleven children—together possess a kettle, a wok, several sharpening stones, dart quivers and blowpipes, sleeping mats, an ax, a few ragged clothes, a tin box and key, two flashlights, a cassette player, three tapes, eight dogs, two monkeys.

"The Penan are so profoundly different," Ian remarks later that night. "They have no writing, so their total vocabulary at any one time is the knowledge of the best storyteller. There is one word for 'he,' 'she,' and 'it,' but six for 'we.' There are at least eight words for sago, because it is the plant that allows them to survive. Sharing is an obligation, so there is no word for 'thank you.' They can name hundreds of trees but there is no word for 'forest.' Their universe is divided between *tana' lihep, tana' lalun*—land of shade, land of abundance—and *tana' tasa'*, the land that has been destroyed."

"In the place they want us to live," Asik says, referring to the Malaysian policy of encouraging the Penan to settle in places like Long Iman, "the sago is gone, and the trees have been destroyed, and all the land is ruined. The animals are gone, the rivers are muddy. Here we sleep on hard logs, but we have plenty to eat."

Addressing a meeting of European and Asian leaders in 1990, Prime Minister Mahathir Mohamad remarked, "It is our policy to eventually bring all jungle dwellers into the mainstream. . . . There is nothing romantic about these helpless, half-starved, and disease-ridden people."

"We don't want them running around like animals," says James Wong, Sarawak's minister for housing and public health. "No one has the ethical right to deprive the Penan of the right to assimilation into Malaysian society." While a number of individual Penan have benefited from the economic development of the past 30 years and the population has more than doubled, largely because of improvements in basic health care, for the vast majority in the longhouses there has only been impoverishment.

Malaysian policies have drawn criticism from anthropologists and human rights activists, including David Maybury-Lewis, professor of anthropology at Harvard and president of Cultural Survival, a nonprofit organization that works with indigenous peoples. Maybury-Lewis views the Penan situation as symptomatic of a global dilemma.

"Genocide, the physical extermination of a people, is universally condemned," he says. "But ethnocide, the destruction of a people's way of life, is not only not condemned when it comes to indigenous peoples, it is advocated as appropriate policy."

The Malaysians want to emancipate the Penan from their backwardness, which means freeing them from who they actually are. Indigenous peoples such as the Penan are said to stand in the way of development, which becomes grounds for dispossessing them and destroying their way of life. Their disappearance is then described as inevitable, as such archaic folk cannot be expected to survive in the modern world.

The idea that indigenous societies are incapable of change and bound to fade away is wrong, according to Maybury-Lewis. Cultures disappear

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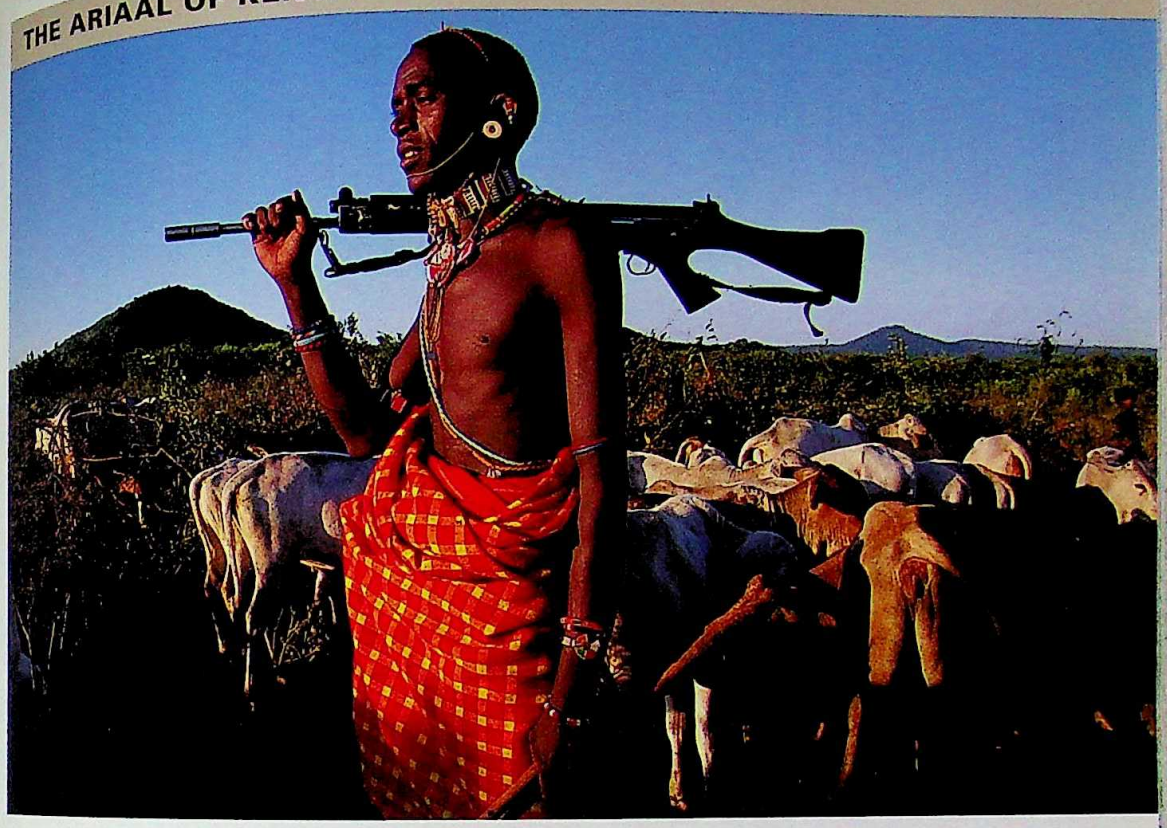

To match the firepower of armed cattle raiders, an Ariaal warrior carries a rifle supplied by the government. "Without guns we'd be sitting ducks," says Joseph Lekuton, an American-educated Ariaal tribesman. Dependent on cows for the milk and blood that nourish them, the 10,000 Ariaal around Mount Marsabit remain largely nomadic, resisting government pressure to settle.

only when they are overwhelmed by external forces and when conditions imposed upon them render them incapable of adapting. "Too often," he says, "we meddle with lives we barely understand."

STUDDED WITH CRATER LAKES and blanketed by lush forests, Mount Marsabit stands as a fertile sentinel above the barren sands of northern Kenya. To the east a flat horizon reaches to Somalia. To the south and west lie the Kaisut Desert and, beyond, the Ndoto Mountains, a rim of peaks rising more than 8,500 feet above the white heat of the lowlands. For thousands of years pastoral nomads thrived here because they and their animals traveled lightly on the land. Mobility was the key to survival. Drought, the long hunger that descends ruthlessly from a searing sky, was not a cruel anomaly but a constant if unpredictable feature of life and climate. Surviving drought was the essential challenge that made the desert peoples of Kenya who they are.

In the wake of a series of especially devastating droughts in the 1970s and '80s, along with famine induced by ethnic conflict and war in neighboring Ethiopia and Somalia, international organizations arrived by the score to distribute relief. Mission posts with clinics, churches, schools, and free food drew the people from the parched land. At the same time and despite evidence to the contrary, it became accepted in Western development circles that the nomads were to blame for degrading their environment through overgrazing. In 1976 the United Nations launched a multimillion-dollar effort in the Marsabit District to encourage two of the tribes in particular, the closely related Ariaal and Rendille, to settle and enter a cash economy. This dovetailed with the interests of those

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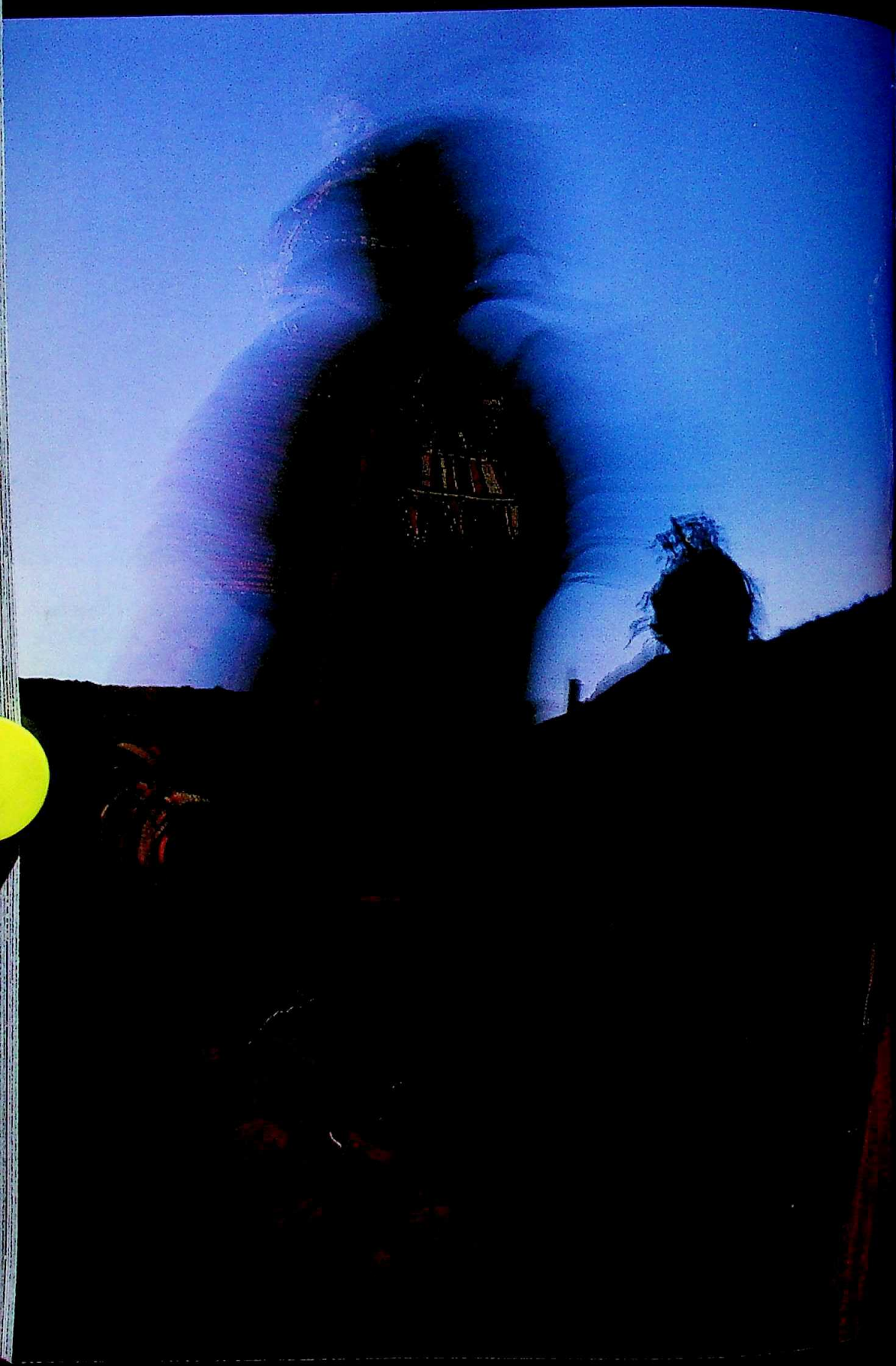
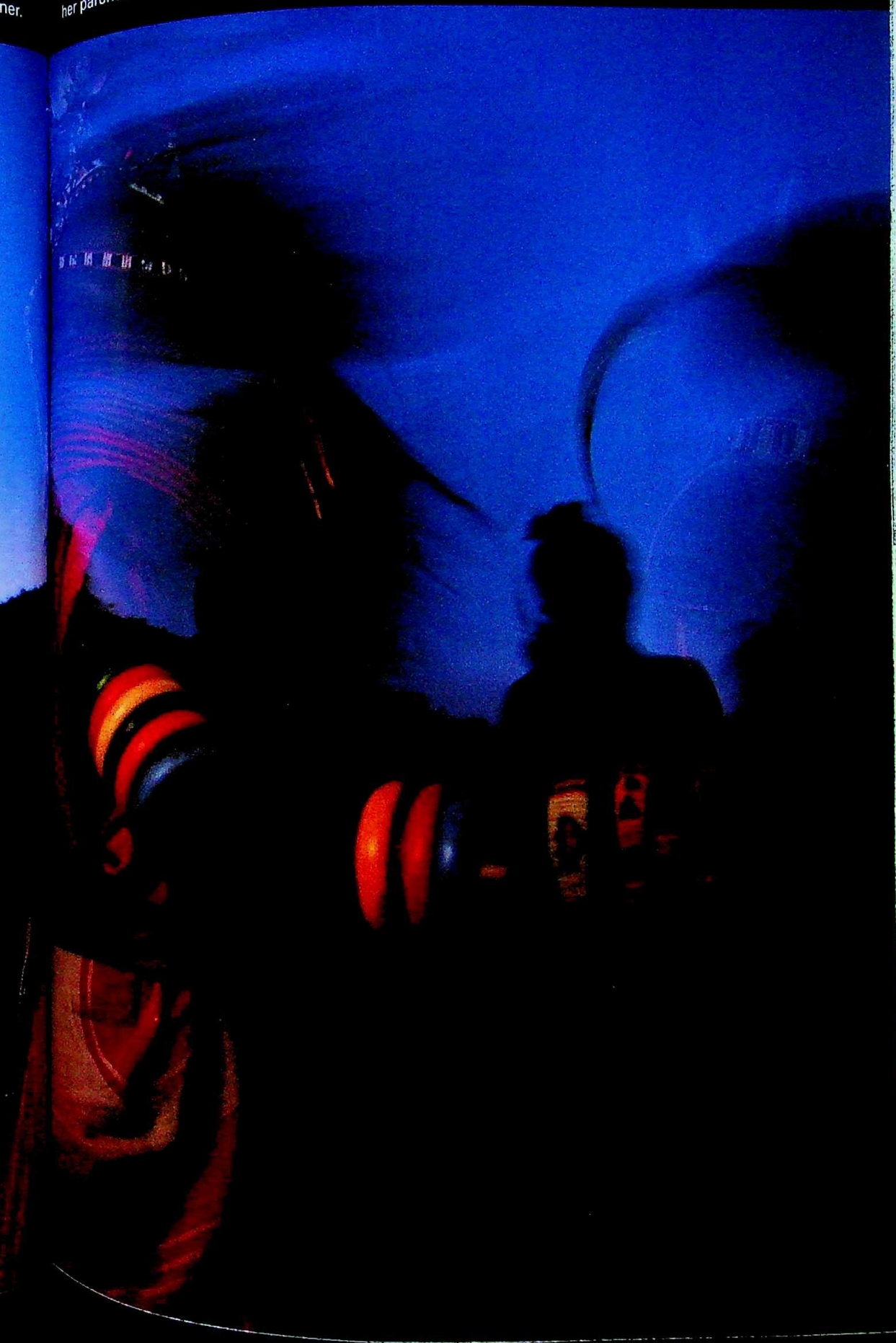


SHOWING OFF THEIR BEST MOVES, teenage girls dance during a wedding celebration in Parkishon, a traditional Ariaal village. Heavy beaded necklaces given to her by a warrior in her clan identify a girl as his *nekarai,* or steady girlfriend and sexual partner.

Yet the pair will never marry. Following Ariaal custom, he will wed a girl from another clan, while she—a silent bystander in a bride-price negotiation between her parents and an older suitor—will be pledged to a man she barely knows.



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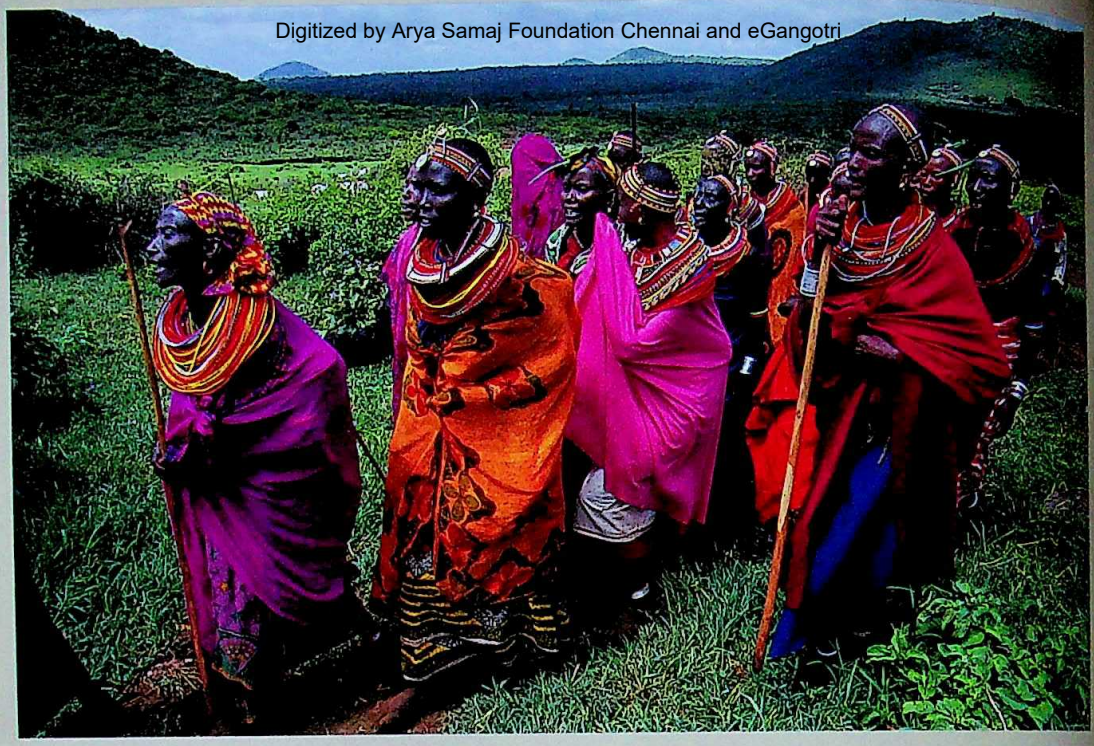

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VOICES RING OUT across rain-washed hills as Ariaal women (top left) make their way to a wedding: *"Meirita ngai nkeera ang!"* they sing. "God bless our children!" All of Marsabit District revels at the end of the rainy season. Warriors and beaded girls prepare for the wedding by applying a makeup of red ocher and sheep fat (top). In contrast to their festive mood, the newly circumcised bride (left, at right) spends much of the celebration in her mother's hut in the company of her best friend. The bride's mother (above) receives the blessing of the elders: a drop of oil from the ox slaughtered for the event.

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Kenyans who considered nomads a symbol of the past and saw education and modernization as the keys to the country's future.

For the 10,000 Ariaal herders, circumstances for the most part weren't so dire that they were forced to settle. On the western flanks of Marsabit and in the Ndoto foothills, where water could almost always be found, they kept cattle, while on the plains far below their camels foraged in the shade of frail acacias. In contrast, the 30,000 Rendille, camel herders of the vast Kaisut Desert, suffered terrible losses in the droughts and drifted by the thousands toward relief camps. By 1985 more than half of them lived in destitution around the lowland towns of Korr and Kargi, their well-being inextricably linked to mission handouts.

WRAPPED IN A RED SHAWL, an old man with a wizened face and earlobes studded in gold reaches for my hand and nonchalantly spits into my upturned palm. "It's a sign of greeting," explains Kevin Smith, a young anthropologist from Utah State, as we walk with one of his closest Ariaal friends, Jonathan Lengalen, through Karare, a community on the southern slope of Mount Marsabit. With a full moon over the grassland, Jonathan leads us along a chalky trail to his *manyatta,* a cluster of domed shelters built of branches and mud, cow dung and hides. From the shadows emerge the Ariaal warriors, tall and thin, their long hair woven in tight braids dyed red with ocher and fat. Their bodies shine with decoration. All carry weapons, swords sheathed in leather, wooden clubs, iron spears, and the odd assault rifle. They are singing, deep resonant chants that draw the young girls, equally beautiful in beads and ocher, into the clearing. As the warriors move forward, slapping the girls with their hair and leaping into the air, their spears flash in the moonlight.

The singing and dancing last well into the night. With the end of the rains, grass is abundant and milk plentiful. It is a time of great joy, a season of celebrations, and almost every day there is a wedding. Sunrise finds us in a cool mist, walking with Sekwa Lesuyai and his best man as they lead a bull and eight heifers along a trail that climbs toward the home of his bride, Nantalian Lenure. All night the two men have slept beside the animals, guarding the gifts that will secure the marriage. The bride's mother washes the men's feet with milk. The bull is slaughtered, its meat distributed with ritual precision. The elders brew tea and then slip away from the manyatta into the bush to roast and eat their share of the meat. The women stay by Nantalian. "God is big," they sing, "big as a mountain; the bride is beautiful, sweet as perfume." Only in the late afternoon do the warriors arrive, to resume their dancing with an intensity that drives several into a trance.

Two days later Jonathan invites us to spend a night in one of the remote encampments, or *fora,* where the warriors live apart with the young lads, managing and protecting the herds, raiding enemy tribes. For ten years, from the time they are circumcised until they are finally permitted by the elders to marry, they spend each night in the open, sleeping on the stony ground, living on soups made of wild herbs and on fresh milk and blood, drawn each evening from the neck of a heifer. Sitting with the warriors in the moonlight, with the sound of cattle bells ringing in the night and the friendly faces of Zebu cows crowding the fire, I come to understand how for the Ariaal these animals are the fulcrum of life.

"If we lose our cows," explains Jonathan, "we lose our faith in life itself.

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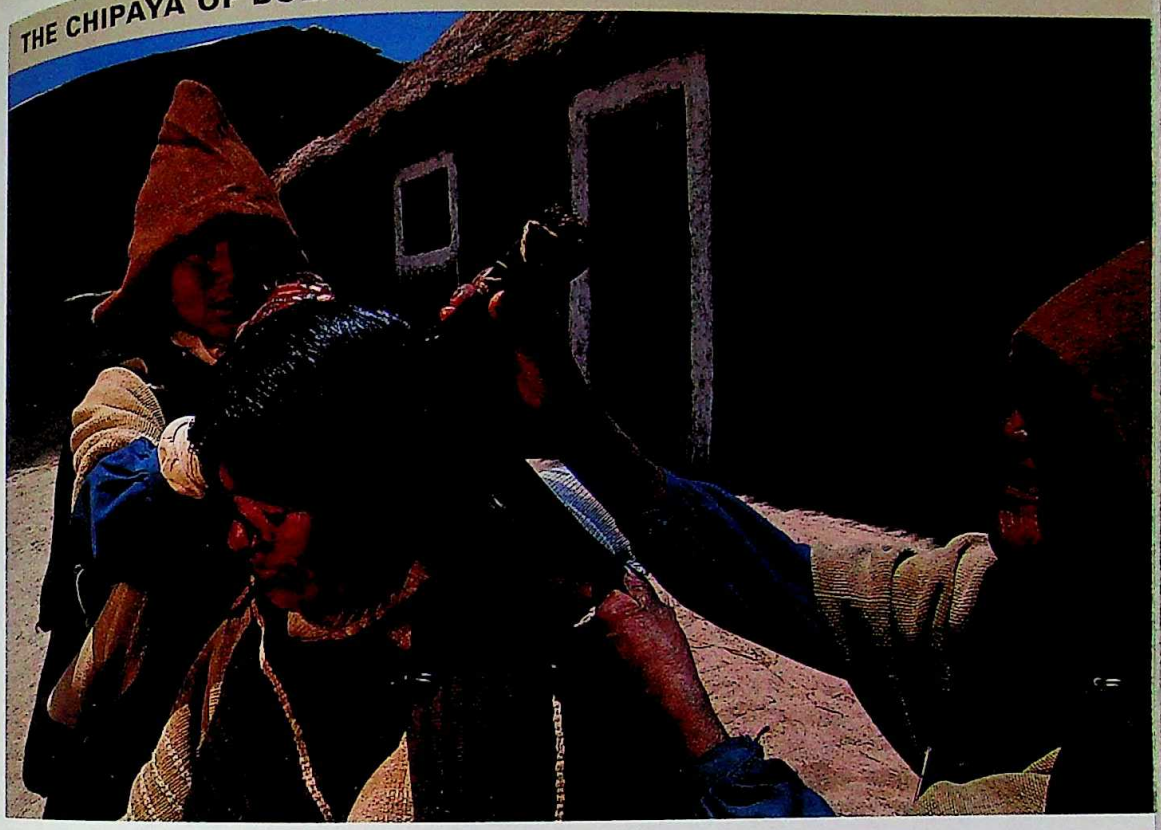

Generations of skill flow through nimble fingers as Chipaya women plait another's hair. When finished, she'll wear a hundred ribbon-thin braids in the style of her ancestors, contemporaries of Peru's Inca. Despite drought, cold, and the lure of city life, some 2,000 Chipaya remain bound to their Altiplano homeland.

All our rituals and ceremonies lose their meaning without the animals."

He reaches for a burning stick, snaps off the ember, and drops it into his empty milk gourd. In the absence of water, it is the way the Ariaal clean the containers. As Jonathan speaks of the tribe, the outline of the culture unfolds in my mind like the pages of an old monograph.

Everything in the culture is built around the need to manage risk. "With a large herd, at least some of the animals will survive," he says. Keeping the herd intact is essential. Managing hundreds of animals creates an incentive to have many children and wives. Polygyny addresses this problem but inevitably creates tensions in the society. With the old men having three and sometimes four wives, there is invariably a shortage of women for the young men. This is solved by getting rid of the young men by sending them off to the warrior encampments. But to make their exit desirable, it is enveloped with prestige.

The highlight of a young man's life is his public circumcision, the moment when he and his peers enter the privileged world of the warrior. The ceremony occurs only every 14 years, and those who endure it together are bonded for life.

"You sit perfectly still," Jonathan remembers, "legs apart, with your back supported by your closest friend. They pour milk on you. Everyone is singing or yelling, warning you not to flinch. All your family promises animals, if you are brave. You can build up a herd just with those frantic promises. But you are so intent. You only hope that the blade is sharp. It's over in seconds, but it seems like years."

Should a boy reveal the slightest expression of fear or pain as the nine cuts are made to his foreskin, he will shame his clan forever and possibly be beaten to death. Few fail, for the honor is immense.

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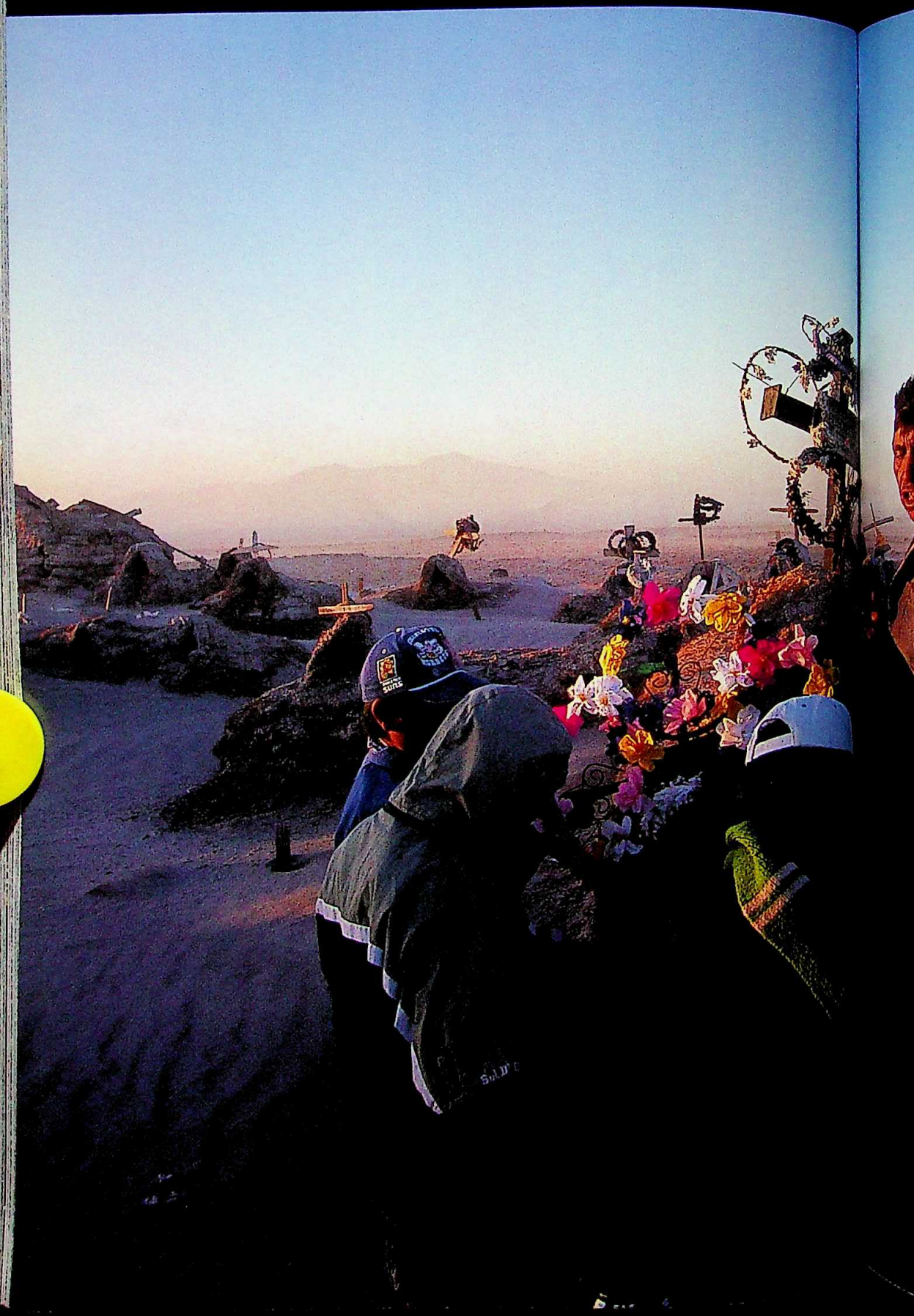
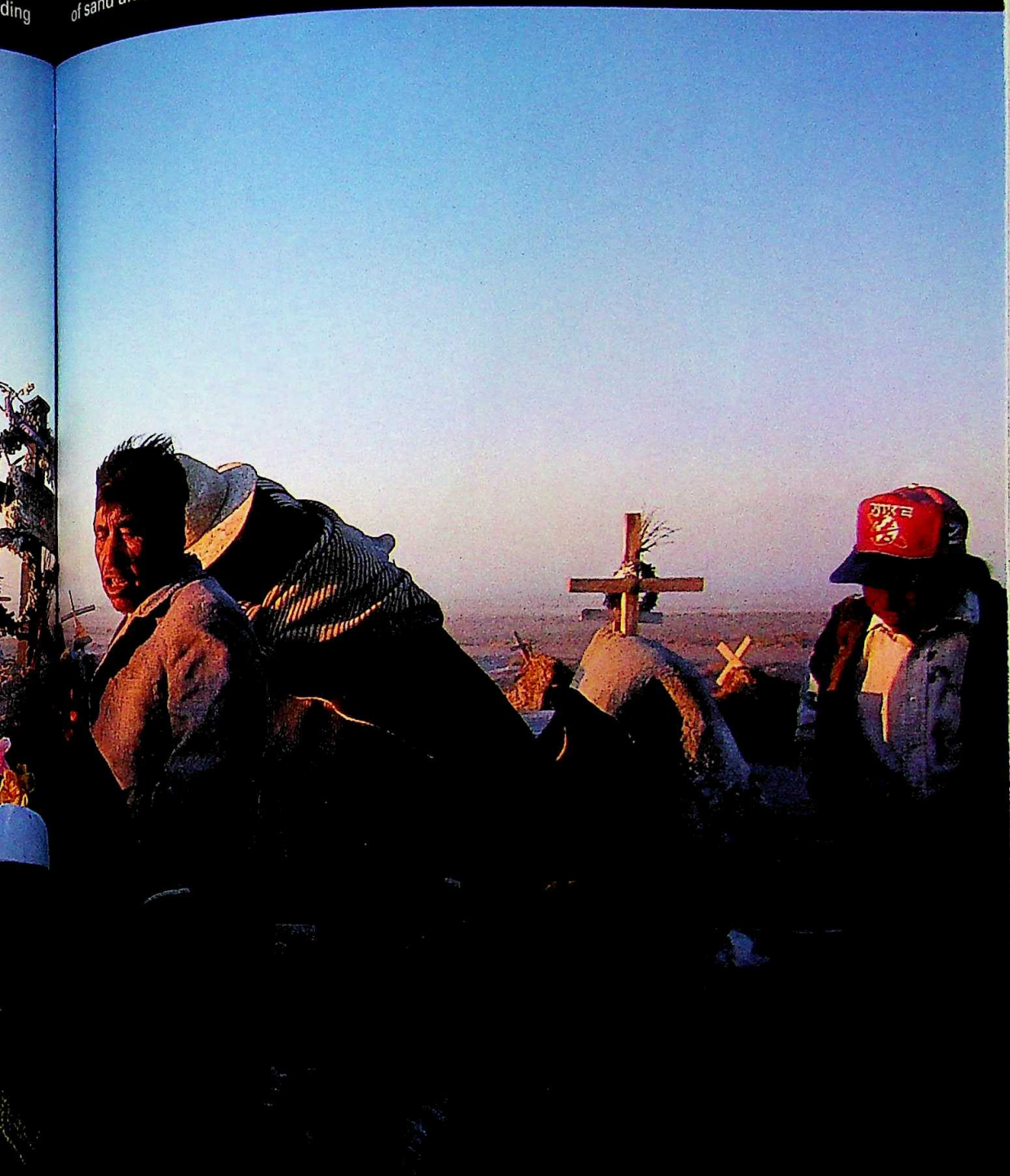
PETITIONING THE SPIRIT, a Chipaya family extends a graveside invitation—"Come home with us!"—to a deceased loved one on November 1, the eve of the Day of the Dead. Relatives return to the cemetery the next day to bid the soul farewell. Blending



Christianity with ancient Andean rituals, the Chipaya call on their gods and ancestors to bless the tasks of daily life in this dry lake bed they call home. In a windswept world of sand and salty soil, their religion is sometimes all that sustains them.



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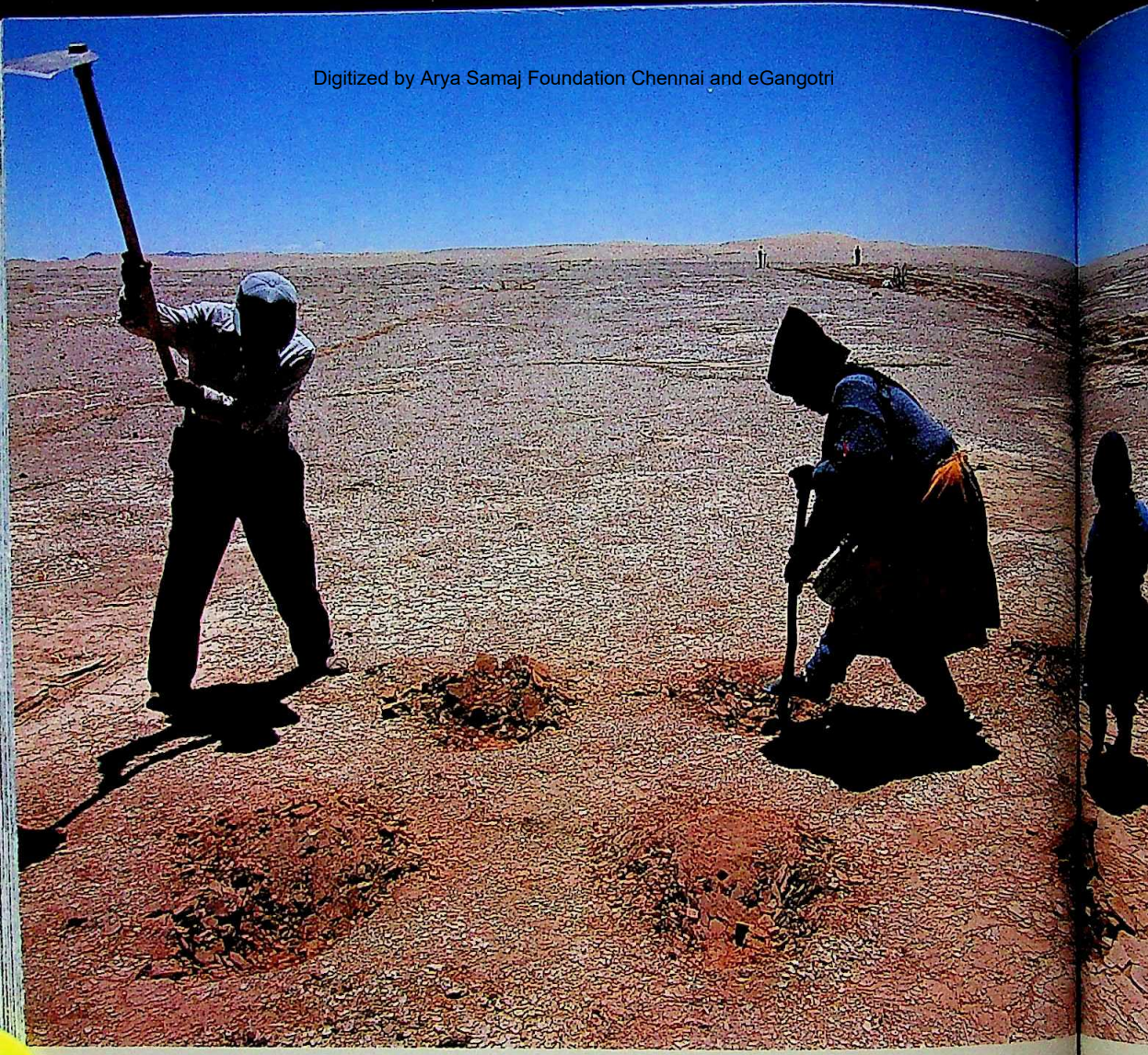

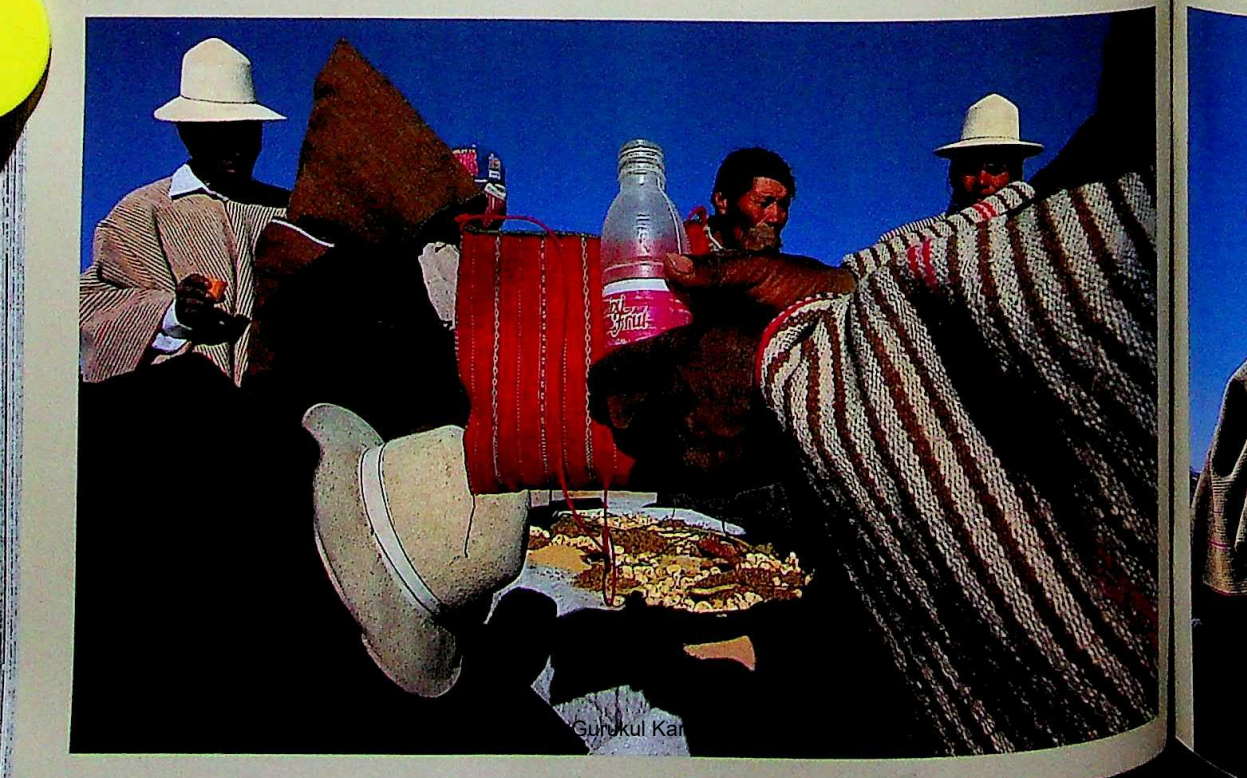

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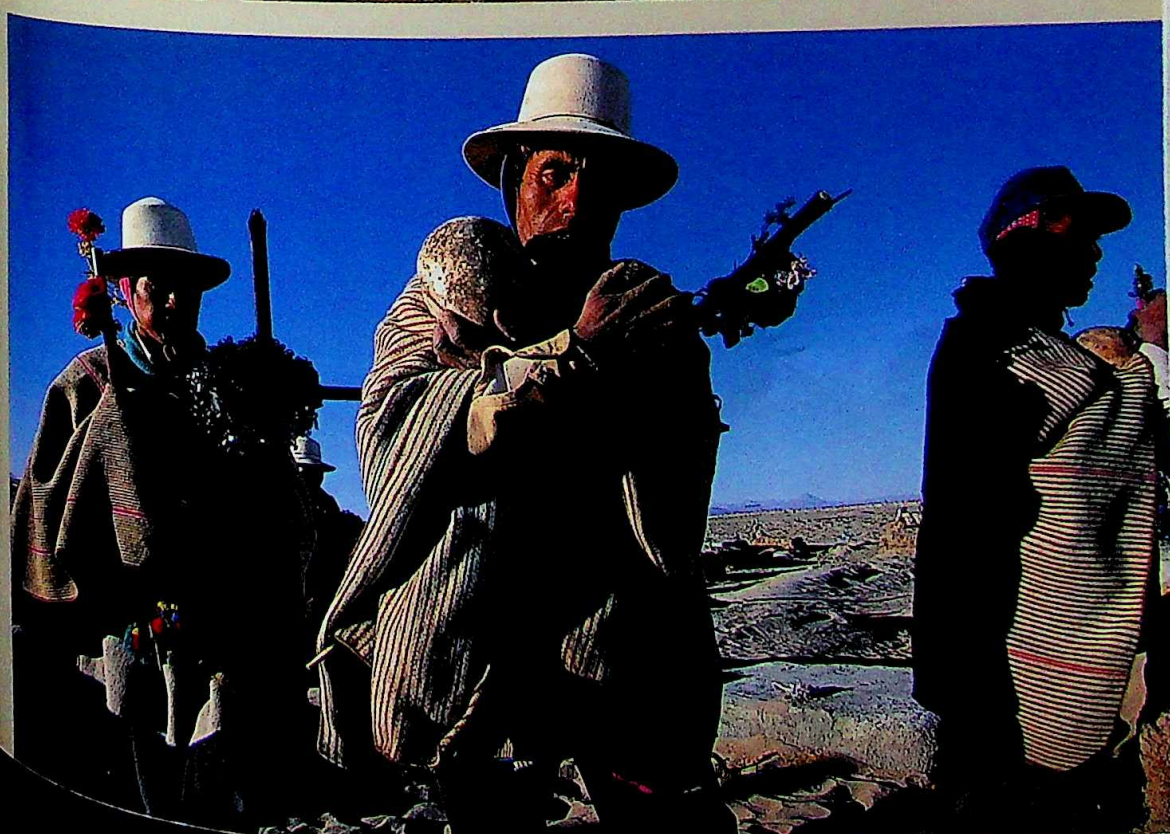
DRINKING A TOAST to the dead, elected representatives of Chipaya clans (bottom left) preside over a Day of the Dead ritual by sharing alcohol and dried coca leaves. Cradling skulls symbolizing the founders of the two original clans (bottom), they return to the cemetery chapel in the town of Santa Ana de Chipaya, confident their ancestors will bless their crops and cattle. In nearby Ayparahui (left) a family battles unforgiving soil to plant quinoa, the staple grain. Each planting season Chipaya farmers channel water from the Lauca River to irrigate and desalt the soil. Santiago and Emiliana Condori (below) graze sheep on patches of sparse grass to produce wool for clothes and blankets.



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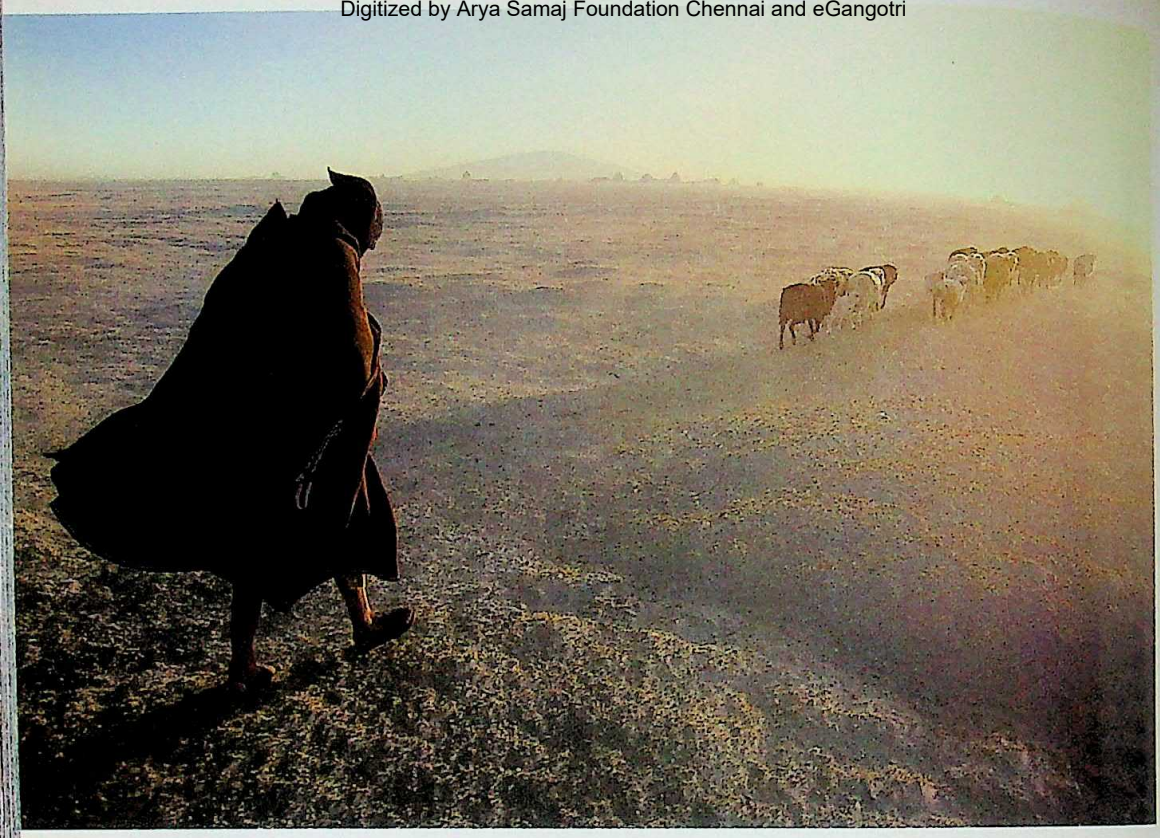

Scoured by gusting sand, a Chipaya woman follows her sheep home across the high plains. As more of her people leave to become farmworkers or housekeepers elsewhere in Bolivia and Chile, will the Chipaya's roots hold, or will they be pulled up and scattered to the winds?

After ten days on the mountain Kevin Smith and I drive to the desert lowlands to visit Lewogoso and Losidan, Ariaal nomadic encampments along the base of the Ndoto Mountains, and then on to the town of Korr, the mission post where so many Rendille had settled. The contrast between the two worlds could not have been greater.

In the Ariaal manyattas traditions are strong and enduring. On rocky outcrops warriors painted in ocher stand like raptors overlooking the narrow traffic of camels and cattle on desert trails. At Lewogoso women and children are herding goats and sheep and drawing blood in the morning from the faces of camels. At Losidan a death has occurred. The manyatta is deserted; by custom the people have moved on. Following them into the desert, we meet Kanikis, a *laibon,* a healer and soothsayer, who reads the future in colored stones and bones tossed from a gourd onto a green cloth spread out in the shade of an acacia tree. Fighting sorcery with amulets and herbs, he protects livestock and people while providing an anchor of spiritual certainty in a harsh land.

As recently as 1975 Korr was a seasonal watering hole visited by small bands of Rendille camel herders. That year Italian missionaries set up a few buildings to distribute relief. Within a decade a town existed, with shops, schools, and a large stone Roman Catholic church. Today there are some 2,500 houses within walking distance of the mission, a local population of 16,000, and 170 hand-dug wells. Missing are the trees that once gave shelter in a windswept desert. Most have been cut to produce charcoal to cook maize gruel, the staple subsidy. Those Rendille who still own camels and goats must herd them far from town, in distant rangelands. Fresh milk is hard to find, and many children go without. In place of sisal, the houses are roofed in cardboard, burlap, and metal sheets

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bearing the names of relief agencies. A walk around town reveals that almost every Western nation has helped create this oasis of dependency.

FOR MANY RENDILLE it was not just food but a chance to educate their children that drew them to Korr. In the face of drought, having at least one child in school destined for the cash economy was another means of managing risk. One who made that choice is our host, Kawab Bulyar Lago, a Rendille of 48. Born in the desert but crippled by polio during his teens, Kawab grew up in a mission and became one of the first of his tribe to be educated. With seven children, Kawab sold his animals and saddled himself with debt to send his son Paul to Catholic school outside Marsabit. Now awaiting the results of the national exams that will determine his fate, Paul hopes to attend university and become either a doctor, a civil engineer, a teacher, or even a tour guide. "I'd prefer to be a doctor," he tells me one morning, "but anything would be all right."

As I listen to his stories of school, with its curriculum dominated by Western religious studies, of the dormitory teasing he endured that led his father to have him circumcised in a hospital before his time, I sense his anxiety and cannot help but recall the calm authority and confidence of Kanikis, the healer, a young Ariaal man of similar age so firmly rooted in tradition. The weight of the world rests on Paul's shoulders. In the old days he would have inherited his father's herd. Today he inherits his hopes and dreams. The family has staked everything on his education. Kawab knows the risks. "For the few who benefit, who get good jobs, they do well," he said. "But most just suffer. Here you can survive. People will help you. In the cities they just leave you to die."

Too often education is a ticket to the bottom rung of an economic ladder that goes nowhere. Unemployment rates in Kenya's cities hover around 25 percent. Among those who have attended school in the Marsabit District, well over half are unemployed.

The danger of Western-style education is clear to many Ariaal, including Lenguye, an elderly midwife from Ngurunit, an Ariaal settlement in the foothills of the Ndoto Mountains. "We send our children to school, and they forget everything. It's the worst thing that ever happened to our people. They only know how to say 'give me.'"

If the Ariaal are to retain the power and spirit of their traditions, perhaps the best hope lies in a new kind of education, in which the curriculum is tailored to their needs. Rather than quartering nomads in boarding schools and teaching them to be clerks, perhaps the teachers should be sent to the Ariaal manyattas to share knowledge of veterinary medicine, range management, and dryland ecology.

In the end the cultures that survive will be those that are willing and able to embrace the new on their own terms, while rejecting anything that implies the total violation of their way of life. In Borneo, throughout the homeland of the Penan, the sago and rattan, the palms, lianas, and fruit trees lie crushed on the forest floor. The hornbill has fled with the pheasants, and as the trees fall in the forest, a unique vision of life is fading in a single generation. In the deserts of northern Kenya, despite droughts and famine and countless other pressures from within and without, the Ariaal have, for the moment, found a way to stay. □

Learn more about the challenges facing the world's aboriginal cultures and share your thoughts online at *www.nationalgeographic.com/2000/culture/lost.*

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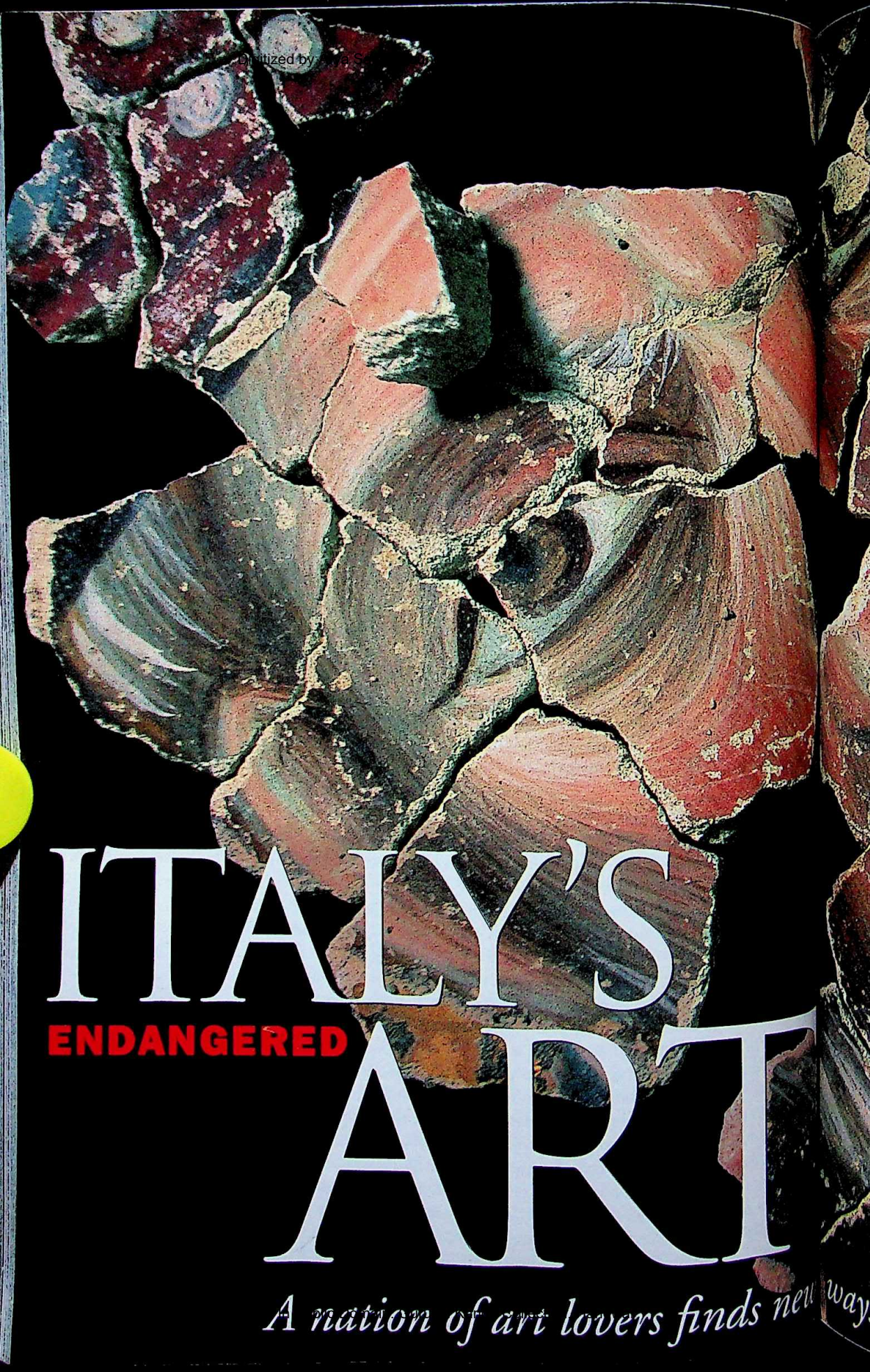

ITALY'S ENDANGERED ART

A nation of art lovers finds new ways

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Shattered during earthquakes in Assisi, the face of St. Rufino stares out from reassembled rubble at the Basilica of St. Francis. Natural disasters, modern hazards, and age-old decay threaten Italy's heritage. Equipped with new ideas, citizens and scientists labor to preserve it.

SOPRINTENDENZA BAAS UMBRIA

new ways—and will—to save its priceless legacy.

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By ERLA ZWINGLE

Photographs by O. LOUIS MAZZATENTA

FISHERMEN OFF SICILY haul in their nets and find they've dragged aboard a 2,200-year-old Greek statue. Workers in the port city of Ancona break ground for a parking lot and discover storerooms dating from A.D. 600. An airplane mechanic strolling outside the Venice airport on his lunch hour bends down and picks up a Roman coin—a rare sestertium minted by the Emperor Galba in A.D. 68. In Italy all this is practically normal.

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Out of the grasp of looters, a Roman soldier shares a shed with other statues removed from display in Rome's Villa Borghese gardens after theft and vandalism. Since 1970 thieves have pilfered some 523,000 treasures in Italy; trained "art police" have recovered about a third.

Paintings, palaces, churches; towers and frescoes; manuscripts and bridges and gardens; Etruscan tombs, Greek temples, early Christian chapels, Roman triumphal arches—Italy contains an apparently inexhaustible trove of treasures, the remains of thousands of years of history. Museums can display only the merest sampling. As the Italians are prone to say, the whole country is a museum.

These works are fighting for their survival. Art of every type is confronted by an endless assortment of threats: fire, flood, earthquake; thieves, vandals, and terrorist bombs; bureaucracy and corruption; man-made environmental hazards from humidity to bright lights to traffic fumes; insects that eat books, airborne chemicals that eat stone, and salts that corrode. The effects of industrialization and of mass tourism, added to chronic lack of money, personnel, and even concern, have taken a heavy toll.

The world responds to crises with instant

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"Those things that do not suffer mortal death, Are swiftly conducted to their end by time."

—POET PIETRO ARETINO
Arezzo, 1512

Gutted by termites, a 16th-century bank ledger earned a place as a cautionary tale in the museum of Rome's Book Pathology Institute. Often criticized as haphazard, Italy's efforts to conserve its past are hampered by a lack of data—no catalog exists of all the country's art and its condition.

generosity and worries about Leonardo's "Last Supper" and the ceiling of the Sistine Chapel. Yet for every masterpiece that earns international attention, there are thousands of artworks leading lives of quiet desperation.

But this story isn't about paint, plaster, or museums. It's about the wealth of art that forms the body and soul of Italy and that forms part of daily life for ordinary people—and about the silent army that is laboring to save it. Although the amount of wear obvious

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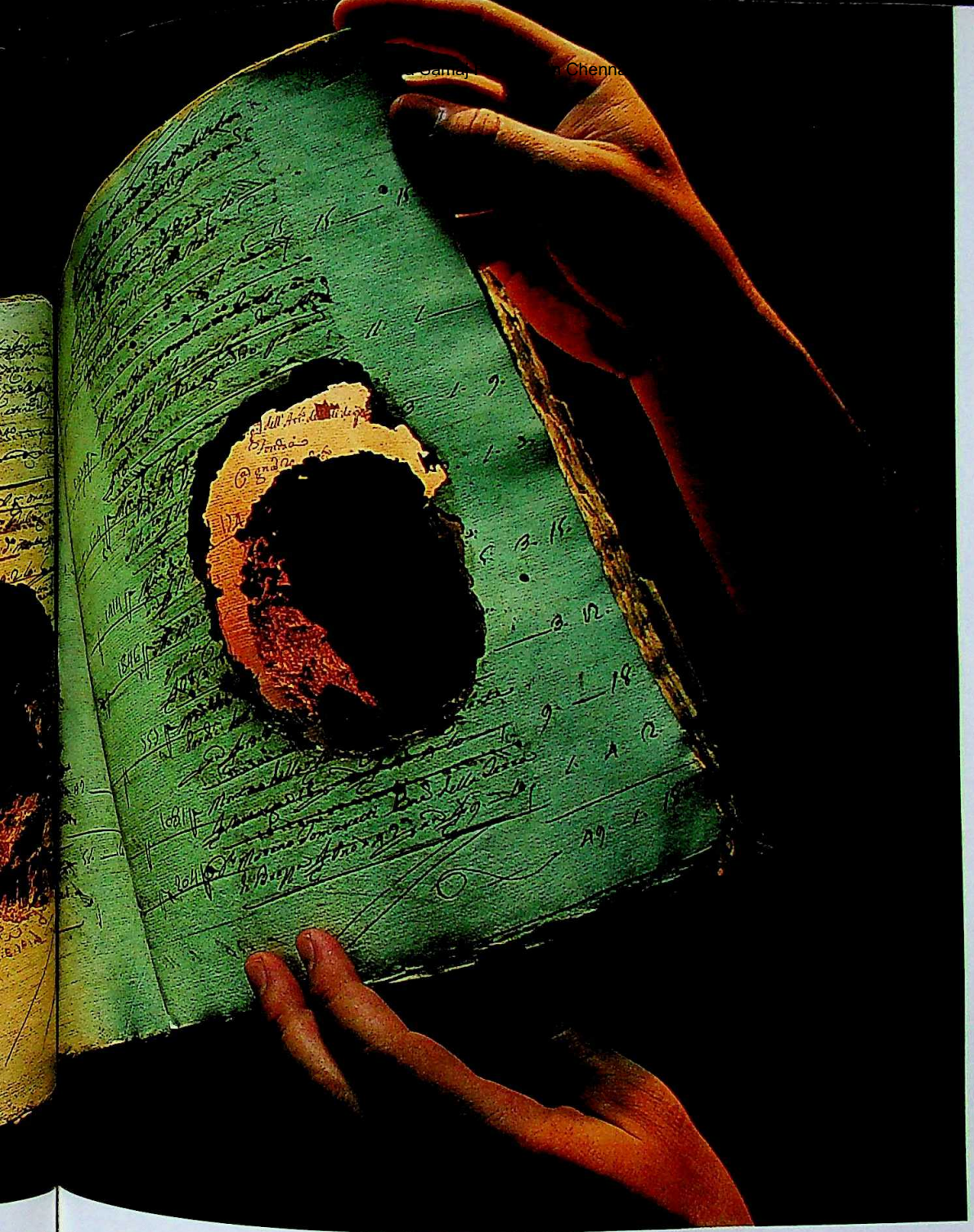

to any passing tourist may give the impression that no one cares, in reality the Italians' rapport with their art is a contradictory relationship of intense intimacy. It's not unusual for an Italian to be baptized in a medieval church patched with bits of Roman ruins, to kick a soccer ball against the walls of a Renaissance palace after school, to drive past Carthaginian castles on the way to work. Yet Italians can also show a surprising apathy toward the very treasures they grew up with, a disengagement fostered by centuries of ownership of art by the church, the state, and the nobility.

"There has been the sense that there's no moral obligation of the citizens to protect their cultural patrimony," said Gianfranco Mossetto, professor of the economics of art at the University of Venice. "We need to regain the sense of being the true proprietors of these treasures."

In the past four years this has begun to happen. A burst of energy, ideas, new laws, and money has begun to give Italy's art hope for a

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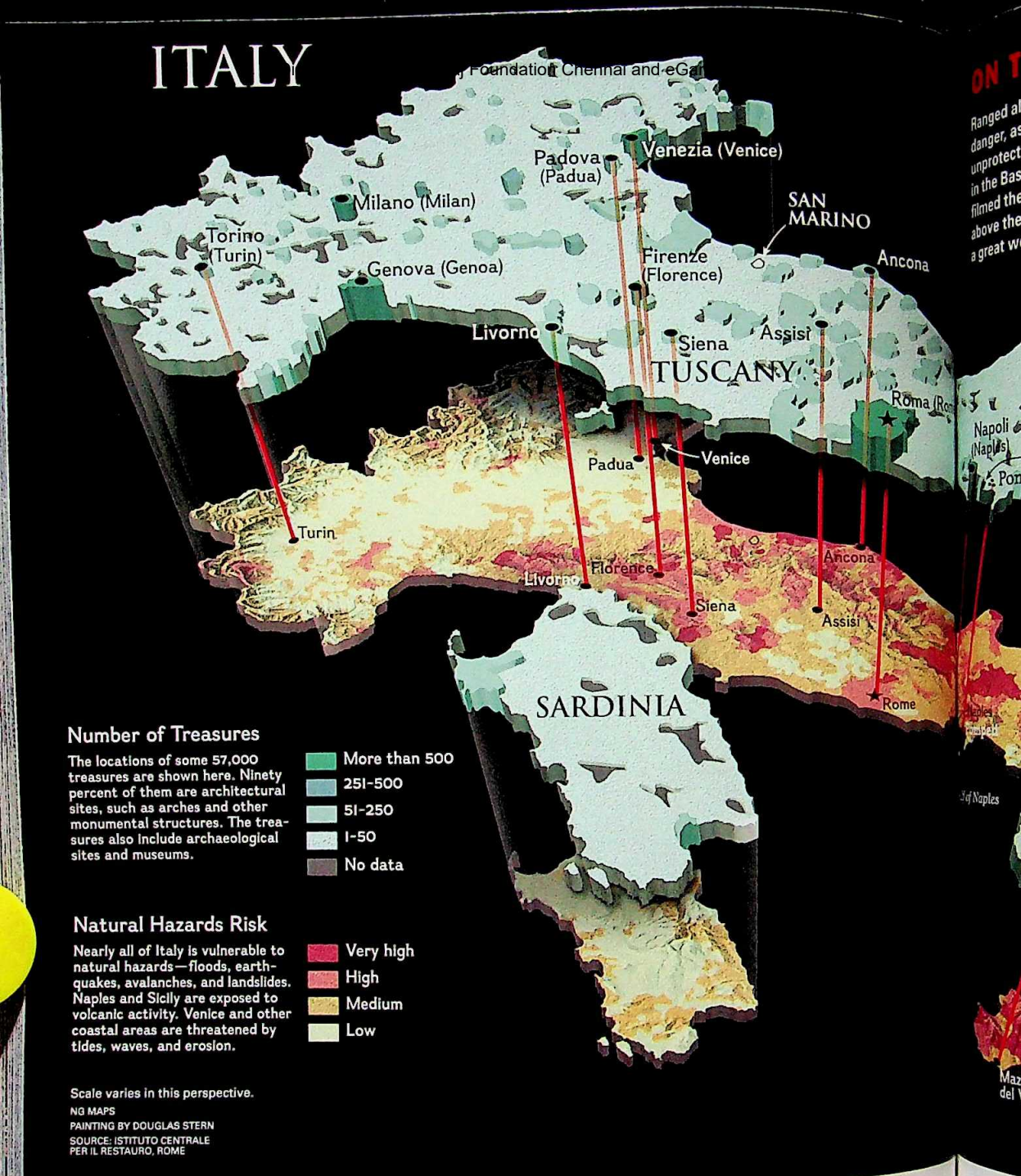

better future. Bureaucrats, restorers, and ordinary Italians have begun to change their thinking, and the results are more surprising, and perhaps more important, than the finding of another Greek statue or another Roman coin.

In an immense vaulted room that was once the stable beneath the medieval monastery of St. Francis in Assisi, Giulio Cenci is trying to put together a puzzle. He stands under bright fluorescent lights amid long tables covered with trays full of thousands of bits of painted plaster, many no larger than coins. He picks one up and blows on it gently to remove the dust—a brush might damage it further. All I see is a fragment of red with a few random white marks. What Cenci sees is something much bigger.

On September 26, 1997, earthquakes shook Assisi. The 13th-century Basilica of St. Francis stood firm, but several interior vaults collapsed. Crashing to the floor were 1,900 square feet of luminous frescoes, a shining army of

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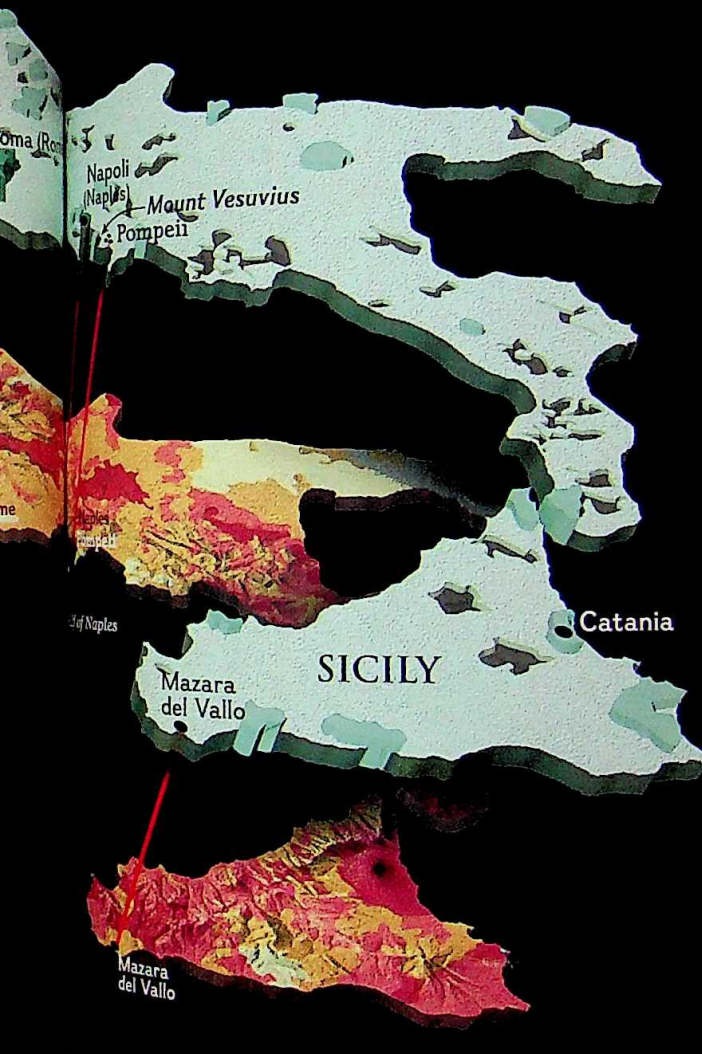
ON THE FAULT LINE

Ranged along a peninsula shaken by earthquakes and swept by floods, Italy's art is never far from danger, as shown by these maps. Despite obvious risks, much of the country's patrimony goes unprotected. On September 26, 1997, violent tremors near Assisi collapsed 13th-century ceilings in the Basilica of St. Francis, killing four people and pulverizing frescoes as a television cameraman filmed the devastation. Experts blamed the tons of loose debris that had accumulated for centuries above the vaults. Quick work in the months that followed saved the rest of the church. "There was a great wound," says art historian Francesca Cristoferi, "but now hope prevails over destruction."



UMBRIA TELEVISION/MASSIMO SESTINI PHOTOS (ALL)

saints and apostles painted by Giotto and Cimabue, two early Renaissance masters. This infinity of fragments was carefully collected and brought here in the hope that the frescoes could be reassembled. It looked hopeless.

Works of art, like their creators, lead an intensely physical life. Born of a moment of desire, they survive accidents, suffer exhaustion, slowly age, and even face death. Restorers dedicate their own lives to helping them age with some dignity. But, like doctors, they have few illusions. They know that their work will always be approximate.

Giulio Cenci called up the day after the Assisi quakes and offered his services, one of scores of volunteers and experts who rushed to the site. Like many restorers he is passionate, tireless. He led me past tables where five or six people were working quietly, dividing fragments by color and theme. A color photograph of each fresco was propped up by trays full of little piles of rubble.

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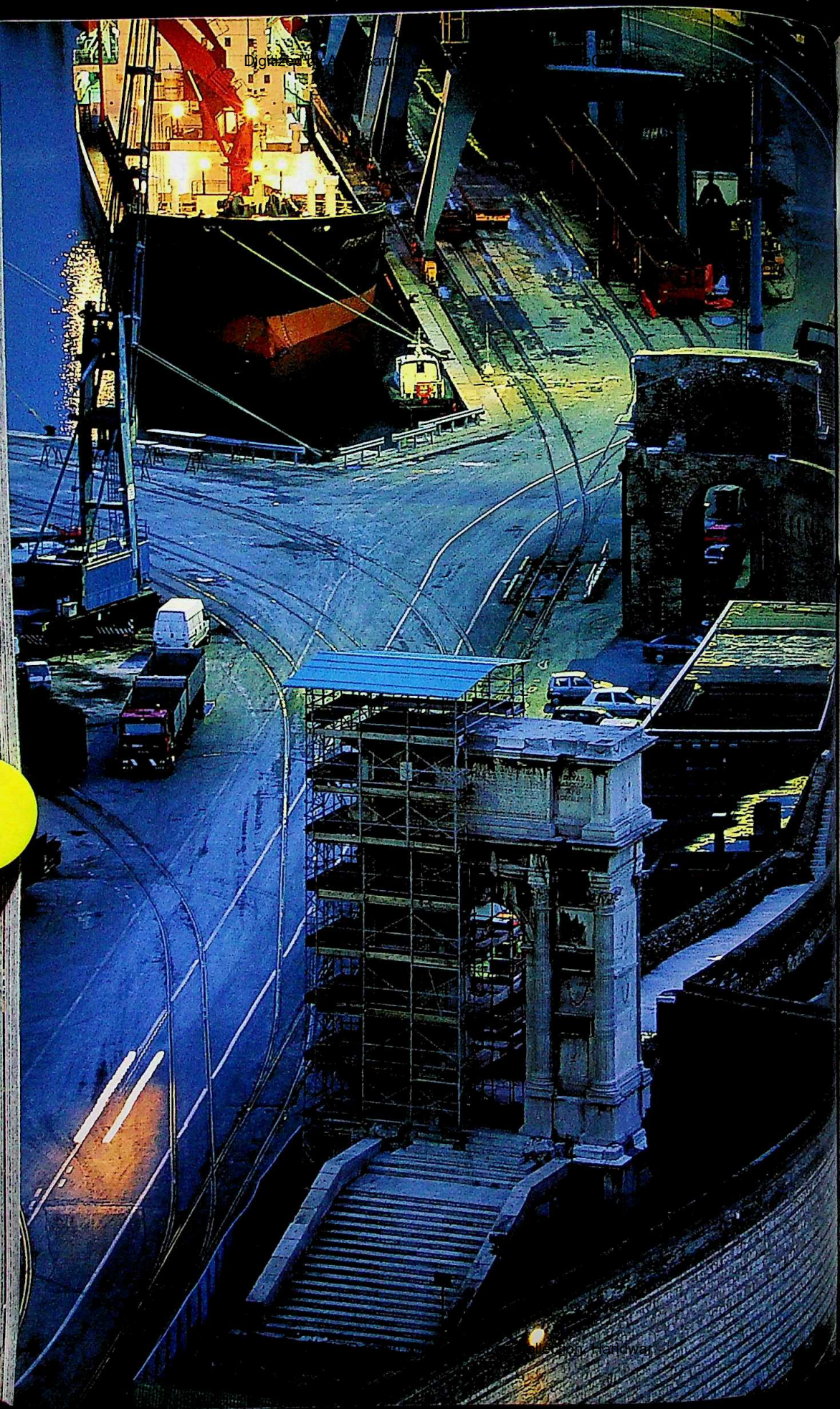

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Many artworks and monuments have lost their context. . . . stuck in the worst possible spots.

"At the beginning it was really upsetting," Giulio admitted. "All the pieces seemed the same. But after three days, you start to recognize differences. And the more you work, the more you see."

We wandered from table to table as he picked up various bits. There is a red bit with feathery white lines: Cimabue. Then a blue fragment with stronger white lines: Giotto. I could already begin to discern differences. "Now we're used to it," Giulio said, "but at first when we went home, we'd close our eyes and still see them. We'd dream of them. . . ."

Without obstacles, the restoration could theoretically be finished in three years. But obstacles abound, primarily funding. There won't be enough money to restore the basilica and all the other damaged monuments and smaller churches in the region, and some people have already complained that Assisi is getting all the attention. The earthquakes also destroyed whole villages; people are living in trailers, and some of them ask why giving money to restore art is more important than helping them build new homes.

We paused before a table in the corner. In one tray was a carefully arranged assortment of apparently random bits. Then I looked closer. Two small pieces side by side: a pair of eyes. Below them, another fragment: a mouth. "This," said Giulio, "is the face of St. Francis." The eyes were earnest, the mouth a little crooked. Lonely, disembodied, but still eloquent. I looked at the numberless fragments and felt an odd tenderness. They seemed so helpless. I murmured something to that effect. "Yes," Giulio agreed without embarrassment. "They start to seem like my children."

In a country littered with famous ruins, Pompeii is one of the most famous. It is also one of the most remarkable archaeological sites in the world: a perfectly preserved city that once held more than 10,000 inhabitants. Buried in A.D. 79 by the ash falling from the eruption of Mount Vesuvius, it is now buried by two million visitors a year who tramp its stony streets admiring the frescoes and forum, not to mention the plaster casts of some of the agonized victims in their death throes.

One spring morning I strolled along a path overlooking the ruins. The trail was a new idea and had just been opened along the city's northern edge. Brilliant red poppies lined the path, and white butterflies flitted among the fragrant rosemary bushes. Birdsong minimized the thrum of distant traffic along the misty Gulf of Naples.

Pompeii spread out below me, its orderly streets and broken walls already teeming with thousands of people. But up here just three of us walked through what was once a quiet neighborhood of luxurious villas. Here, at least, I could still detect the faint pulse of the city as it once was and not the throbbing of the tour groups with their jaded guides.

More than two and a half centuries have passed since Pompeii was unearthed, and it now gives the impression of an orange that has been sucked dry. Major excavations have been halted for years, the area open to the public has shrunk, while the number of visitors has steadily increased. The city must have been fascinating once, but the shelves of broken pottery are monotonous and the famous frescoes in the Villa of the Mysteries are worn and chipped.

But Pompeii is beginning to come alive again, owing to a dramatic transfusion of money. Pompeii is the test case of a law granting greater financial authority to superintendents of Italian monuments. Until now all money from entrance fees to museums or monuments had to be turned over to the state, which then reallocated the funds to each site.

That was great for smaller places that couldn't expect to earn much, but it was very bad for the big players. In a year, Pompeii might take in eight million dollars at the gate,

Out of place and time, the second-century Arch of Trajan leads from a flight of 19th-century steps into the busy port of Ancona. Having survived centuries of salt air and more recently coal dust, the arch is now besieged by engine exhaust and rattled by passing trains. Officials plan to move port facilities farther away.

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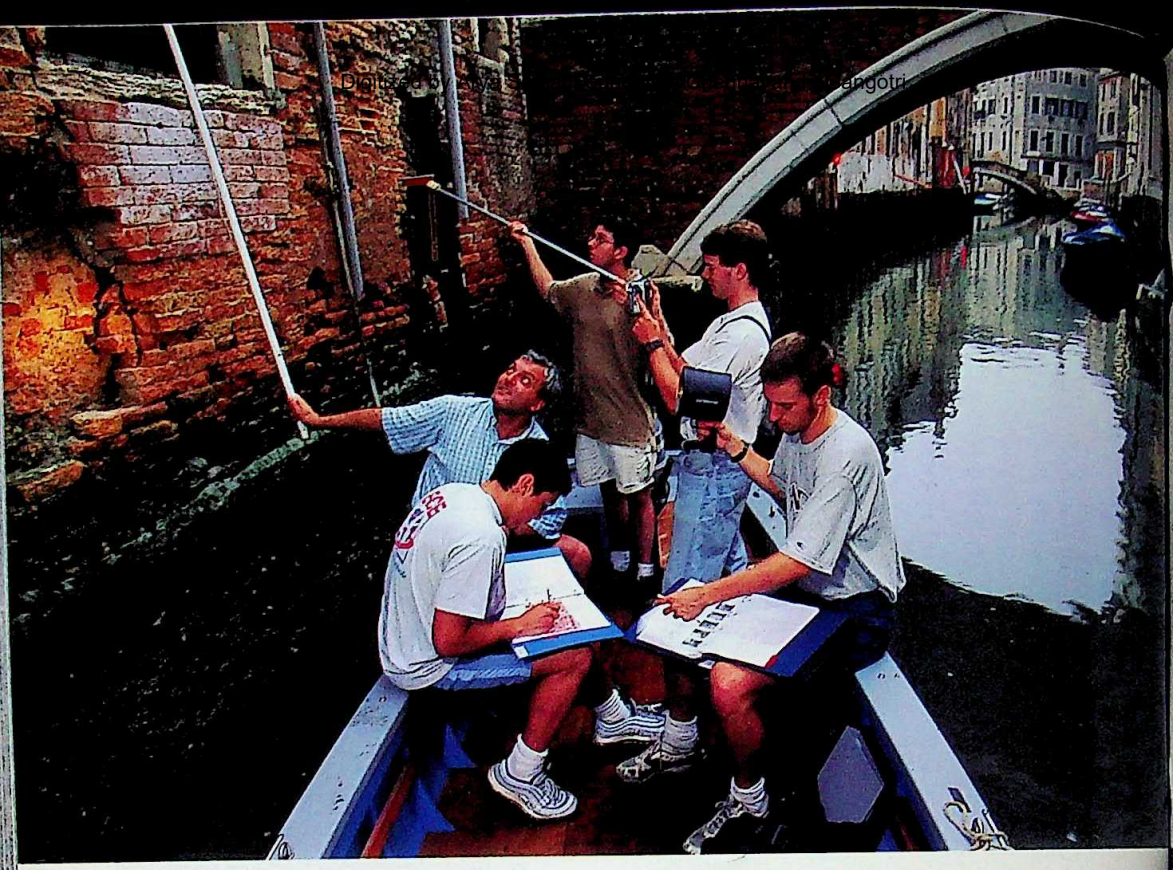

Recording the scene of the crime, computer scientist Fabio Carrera, in checked shirt, and his students gather clues that helped identify the culprits eroding canal walls in Venice: seeping sewage and waves churned up by passing boats. Standing firm, Dr. Gianfranco Falzoni (opposite) heads a group that fought demolition of the Royal Palace of Venaria Reale near Turin, persuading the government to restore it instead.

but it was given only two to three million for its expenses. This was why digs were closed, why there are no decent signs, not even a reasonable map to be had.

Now, after less than a year of greater control, the situation has already begun to improve: The new trail and a new bookshop have opened, and there is talk of new excavations. If all goes well here for five years, more sites may become self-sufficient.

This shift in thinking at the ministry of culture has inspired enthusiasm and optimism in the art world. "Italy's great resource is the fine arts," one expert told me, "but adequate investment hasn't been made in this sector. The arts were viewed as a drain on the economy that should be kept at a minimum, rather than as an investment." When Walter Veltroni became minister of culture in 1995, the government allocated less than one percent of the annual budget to the fine arts. "For many years this ministry was considered the least important," Veltroni told me frankly. "I asked to have this job—and everyone thought I was crazy."

They don't now. Veltroni instituted a new lottery in betting-mad Italy whose income is dedicated to the fine arts. In 1997 this lotto netted 200 million dollars—twice what the state budget had allotted for restorations. In addition the annual income-tax form allows Italians to allocate a percentage of their taxes to the fine arts. This netted an additional three billion dollars. And the tax law has been revised to encourage donors. All over Italy, artworks that had been limping along in genteel poverty now have hope for prosperity. "Ideas are in the air," Veltroni said. "You just have to grab them."

EVERY SUNDAY EVENING, within the soaring golden spaces of the Basilica of San Marco in Venice, the faithful chant the Litany of the Blessed Virgin Mary. This moment is especially beautiful in winter, when the chill darkness and fog outside give the church the atmosphere of some fantastic cavern, gleaming with

Former staff members ERLA ZWINGLE and O. LOUIS MAZZATENTA often cover Italy for the magazine.

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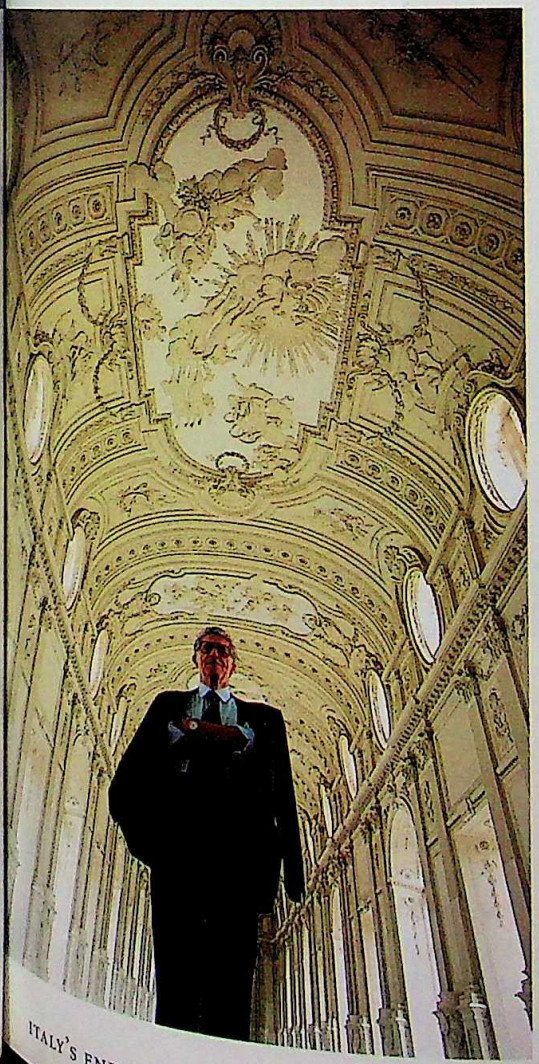
Venice represents the clearest result of all the dangers facing Italy's treasures.

mosaics, smoky with incense, full of power. The priests pace slowly down the echoing nave as the solemn Latin cadences rise with the heat of flickering candles: "Mother of Christ, pray for us. Mother of our Creator, pray for us . . . Mystical Rose . . . Morning Star . . . Queen of Peace."

The procession halts in the chapel of the Madonna Nicopeia, where a Greek icon of the Mother and Child has hung above a small altar for 700 years. This icon is small and simple, but in the light of the candles Mary's face seems to glow with shy, solemn pleasure.

If you go to the chapel on a weekday morning, what you'll see is just a very nice picture. But on Sunday the icon is more than a work of art: It is a participant, still fulfilling the purpose for which it was created.



By now, though, many of Italy's works of art and monuments have lost their context. Often they are stuck in the worst possible spots, right where sewers, subways, houses, or streets need to go. Superintendents of fine arts and municipal authorities struggle to collaborate—for the equal benefit of the artworks and the pursuit of daily life. And so it is probably inevitable that safeguarding works of art is not a mission that everyone embraces with equal enthusiasm. Even a brief visit to Padua and Venice demonstrates some dramatic differences in outlook.

Padua has long been famous for the Scrovegni Chapel, which contains one of the greatest masterpieces of early Renaissance painting: Its four walls are covered with frescoes depicting biblical scenes including the life of the Virgin Mary painted by Giotto, one of the geniuses of Western art.

Thirty years ago, perhaps 10,000 people visited the chapel each year. Today the number is upwards of a quarter million. Inevitably the frescoes began to suffer. Heat from the lights, shocks from sudden temperature changes every time the door opened, dust, humidity. Increased traffic added acrid fumes to the mix.

I stood in the chapel, looking at the rows of paintings reaching to the ceiling. Angels, saints, and sinners shimmered down from walls that for seven centuries have withstood the elements. I gazed on the elegant, sloe-eyed faces, the desperate angels floating above the crucified Christ as they wailed, clutching their faces, tearing their garments. I wanted to abandon myself to the beauty, but I felt like a microbe standing there. I tried not to breathe. I tried not to sweat.

The city has already made great strides to overcome threats like me. The nearest streets have been closed to traffic. The main entrance will soon be closed and the original side entrance reopened, complete with a closed corridor as entryway, which helps to equalize the temperature. Carbon filters combat dust and humidity. Inside, "cold" halogen bulbs have replaced the hot incandescent lights that once

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Fixing past repairs, restorer Francesca Ciani Passeri applies paint to Rubens's "Triumphal Entry of Henry IV into Paris" in Florence after removing restorations that failed to match the original. Critics charge such retouching can change a painting's character. "We know that any action is aggression," Passeri says, "so we try to limit it."

blasted the frescoes. Sophisticated monitoring systems track the chapel's vital signs. "It's constant work," says Serenella Borsella, an architect employed by the city's museums, "but it will mean minimum interventions. Even my own son isn't cared for like this."

Most Italian cities contain art. In Venice, the entire city is a work of art. Yet while Padua, among other cities, is working hard to resolve the conflicting needs of life and art, Venice often seems to have simply given up. Wander

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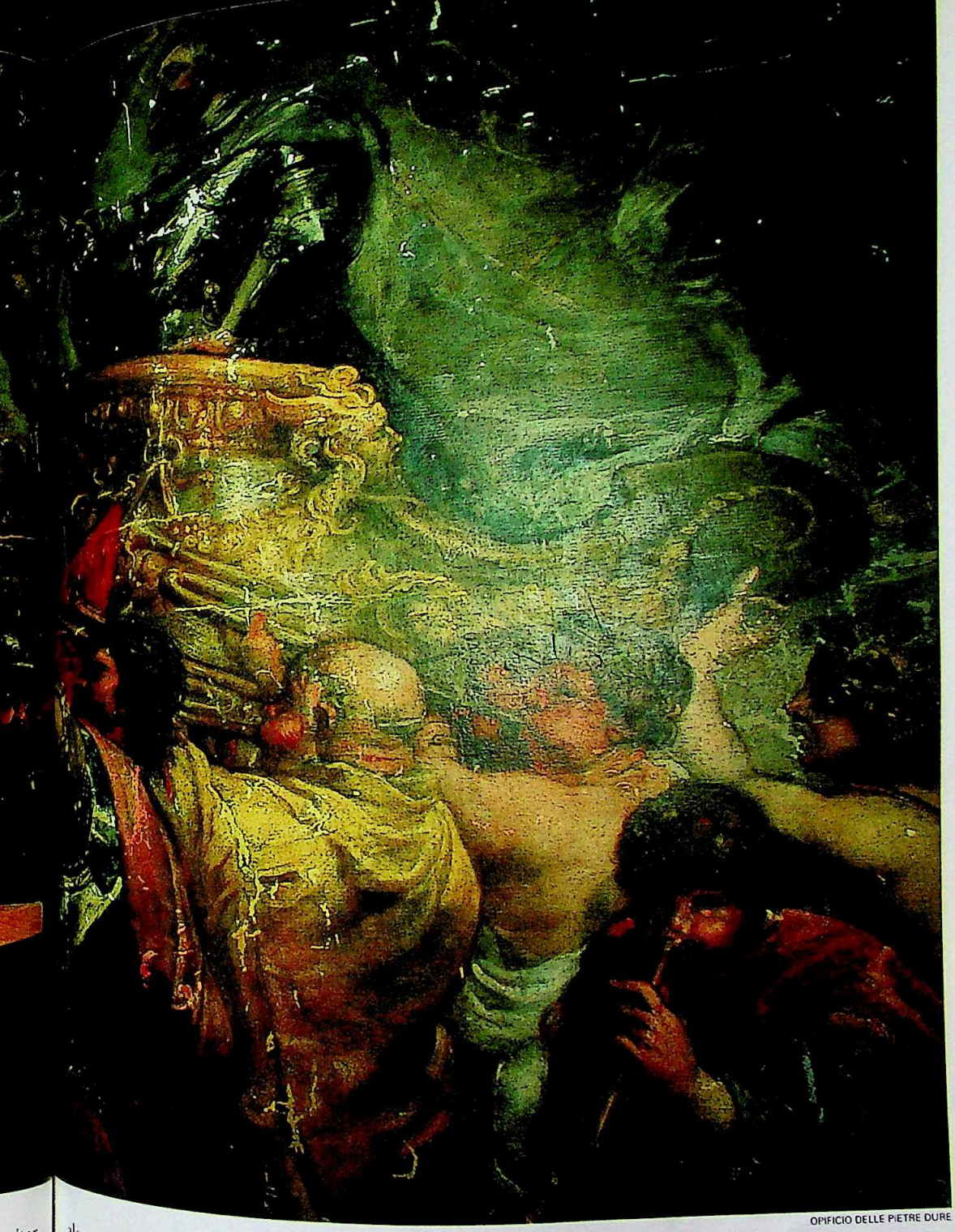

OPIFICIO DELLE PIETRE DURE

along any canal and your eyes will be seduced by the soft yellow and rose and pale greens of the palaces, the sinuous curves of their gothic windows, the secret gardens overhung with roses, all mirrored in the undulating reflections of myriad canals. You don't go to Venice to see art but to live it.

People who worry about Venice believe that the enemy is periodic flooding. Flooding may be the city's enemy, but it is also the waves that are destroying it. If you listen as well as look, especially along the wide Giudecca Canal, instead of peaceful lapping you'll hear slapping. Punching. Thudding. The ceaseless surging of surf produced by every form of motorboat is gouging the foundations right out from under the city. Weakened stretches of walkway are now shielded by temporary walls of iron sheeting to take the brunt of the waves. Cracks are opening up between walls and sidewalks, and low tide reveals crumbling bricks, collapsing slabs of marble, gaping holes.

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"You hear numbers mentioned. But frank

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have no idea how many treasures we have."

—ALESSANDRO BIANCHI
Central Restoration Institute, Rome

Dug up only to be reburied in a multitude of other artifacts, a first-century statue from Pompeii (left) lies orphaned in a Naples storeroom. In Mazara del Vallo on Sicily's southwest coast, a bronze satyr fished up after 2,200 years under the sea gets a freshwater bath (above) before a lengthy restoration. Italy has so much distressed art that it must practice triage: Important pieces get attention first; action on the rest is postponed, sometimes indefinitely.

SOPRINTENDENZA BCA TRAPANI (ABOVE)

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Digital Caesar: Physicist Giorgio Accardo holds his computer-generated plastic model that helped artists reproduce an 1,800-year-old bronze statue of Emperor Marcus Aurelius without touching its fragile surface. The copy stands behind him on Rome's Campidoglio. The original was placed indoors, out of polluted air.

Once the tiniest fissure opens, waves do the rest.

"There's a Venetian saying, 'Water doesn't have bones,' " said Giovanni Borgo, "which means that it can go wherever it likes, even into the smallest spaces." Borgo is acting president of a group called Pax in Aqua (peace in the water), which is dedicated to persuading citizens and government to address this problem. It is discouraging work.

"Certainly there are speed limits," he said, answering my most obvious question. But no

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"Even as we believe less in human immortality, we insist the more on the immortality of these objects."

—ANTONIO PAOLUCCI
Superintendent of Fine Arts and History
for Florence, Prato, and Pistoia

one obeys them. The group has suggested many simple ways in which to minimize, perhaps even eliminate, the waves and their damage. Lowering speed limits is one good idea; actually enforcing them is even better. Regulating the shape of the hulls and the power of the motors would be best of all.

So far the proposals have generated only more discussion. Everyone agrees the waves are a problem, but it's always somebody else's fault. And faced with fierce opposition from various groups (primarily taxi drivers, barge owners, and the public transport company), the city government has dithered.

Venice represents the clearest result of all the dangers facing Italy's treasures: environmental degradation, fruitless political maneuvering, massive bureaucracy, the impact of mass tourism, and, on the part of the citizens themselves, a weird combination of cynicism, impotence, and an almost sublime lack of awareness of the irony of their own actions. The mayor affirmed

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Unlike the actual monuments, it doesn't matter whether models at Rimini's Italy in Miniature survive throngs of sightseers. Even the breathing of hordes of visitors can speed the decay of art. Might tourists at Pompeii one day be channeled into a theme park of the city? Presenting them with an illusion could help save the real thing.

his concern about the wave damage, for example, while another politician proposed granting 300 new taxi licenses. And then there was the day two gondoliers came to a meeting of Pax in Aqua to present a letter of protest. The waves are making their work more difficult, even dangerous, and they wanted to add their voices to those of other concerned citizens.

They came to the meeting in a motorboat.

"THERE'S NO DOUBT," one art historian declared, "that tourism is Italy's petroleum." Tourists provide employment for millions of Italians. They spent nearly 75 billion dollars in Italy in 1997, of which at least 25 billion dollars was from cultural tourism. Many smaller towns, including Assisi, are now almost completely dependent on the flow of tourists for their economic survival.

But mass tourism has hit Italy hard: Two million a year in Pompeii, five million in Florence, twelve million in Venice. The jubilee celebrations of the year 2000 will attract untold millions more. The entire country is bracing for the impact.

They arrive in swarms, from buses, airplanes, cruise ships. You see them in their exhausted hordes under the summer vacation sun, standing in line for hours to enter Florence's Uffizi Gallery or the Vatican Museum in Rome, slumped in shady doorways consuming cold slices of pizza. They are also consuming much of the cultural and historic patrimony they've come to enjoy.

"I think with terror what will happen when that huge ship, the *Grand Princess*, begins to cruise," says Antonio Paolucci, the superintendent of fine arts in Florence. "A stop in Livorno will mean a visit to Florence: 500 tour buses will arrive. They'll all go to the Uffizi to see Botticelli's 'Primavera' and the Accademia to see Michelangelo's 'David.' We can't expand the Uffizi like an accordion."

There are several new ideas afoot to better manage the flow of visitors. One is to extend museum hours; a number of museums are now staying open until 10 p.m., later than

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Tourism has hit Italy hard: Two million a year in Pompeii . . . twelve million in Venice.

anywhere else in Europe. At the Scrovegni Chapel, among others, they are limiting the number of visitors to 25 at a time, and for only 15 minutes. Museums will probably even begin requiring reservations; the Villa Borghese in Rome has already started.

IN THE FACE of this tremendous consumption of art, it would be understandable if the average Italian were to feel that his country's treasures were being restored and presented mainly for the benefit of everyone else. Yet a new pride, planted and cultivated by several tireless pioneers, has begun to flourish.

In Naples it began with the children. A Neapolitan baroness named Mirella Barracco designed a program in 1992 to encourage students to "adopt" a monument, study it, and then during weekends in May act as tour guides. This program has now been copied in 180 Italian cities, as well as abroad.

"At first our foundation concentrated on restoration," Barracco explained. "Then we realized we had to work on the young generation, those to whom these works are entrusted."

Three years ago the students of the Flavio Gioia Middle School "adopted" the imposing 14th-century church of San Giovanni a Carbonara, and each May they stand at the ready, waiting to introduce its wonders to any curious visitor. On a hot Saturday morning a small group of them was somewhat tensely waiting for potential customers, the girls giggling, the boys occasionally punching each other.

When I appeared, Alfonso, a 14-year-old boy from the very dicey La Sanita neighborhood, took me in hand. It was his job to explain the ornate marble tomb of the Miroballo family. He spoke rapidly, in a low, heavily accented monotone, but he used lots of impressive technical terms. He pointed out the statues, the inscriptions. He finished with relief.

I asked if there was something he particularly liked on the tomb. He paused, then smiled. "That part there," he said, pointing to some exuberant cherubs. "It's more simpatico."

Rosario Stanco, the classroom teacher, has been working for years with these irrepressible, disadvantaged teenagers. He understands them. "Many have difficulty in reading and writing," he explained, "so they started 'reading' the monument from life. They used to cut school, but they come here willingly. And through this project I've been able to understand certain aspects of the boys better. I realized that the kids who give you less in the classroom give you more here in these unusual activities. They begin to sense that they're worth something."

In the end Mirella Barracco's project is not really about art. It's about life. That they might be one and the same struck me as quintessentially Italian. "It's the civic sense that we want to create," she said. "The pride that the children feel for their monuments—it's a lifelong project. It's not just for a weekend."

One twilight in Siena, I sat in the spacious Campo, the medieval main square. A perfect half moon hung just above the imposing bell tower, the Torre del Mangia, as swallows swooped through the cooling evening air. Young couples reclined on the sloping brick apron of the square, and three small boys kicked a soccer ball to and fro. A barefoot baby peacefully gnawed a cracker. All of us were looking at the beauty, absorbing it, but we were also part of it.

My thoughts drifted out toward the fantastic panoply of art spreading beyond us under the limpid, pearly sky: the silent temples in the darkness, the paintings inside the quiet churches, the marble angels with broken wings, the archaic mysteries of yet undiscovered tombs. All the art waiting to be revived; the chipped, cracked, flaking handiwork of ages. The endless procession of Madonnas and martyrs, the Roman generals, Gothic princes, all gazing upon the centuries with the same patient, enigmatic expressions. They certainly need us, but we also need them.

Even Alfonso, the incorrigible Neapolitan teenager, understood this. "The art is like a bambino," he told me simply. "It needs to be taken care of." Like children, these treasures require sacrifice, but they repay us with joy. □

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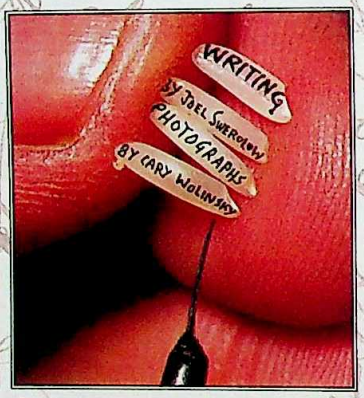
THE POWER OF *Writing*



HANDMAIDEN TO HISTORY, CHRONICLER OF THE MIND AND THE HEART, WRITING IS HUMANKIND'S MOST FAR-REACHING CREATION, ITS FORMS AND DESIGNS ENDLESS. DURING THE U.S. CIVIL WAR, FOR EXAMPLE, A UNION SOLDIER'S LETTER HOME WAS WRITTEN IN TWO DIRECTIONS TO SAVE SCARCE PAPER. IN INDIA AN ARTISAN MADE SUCH LIMITATION A VIRTUE BY INKING THIS ARTICLE'S BYLINES ON GRAINS OF RICE (ABOVE). AND THE WORDS YOU ARE NOW READING WERE WRITTEN ON A COMPUTER EQUIPPED WITH SOME 800 STYLES OF TYPE. YET THE PURPOSE OF WRITING REMAINS UNCHANGED: TO CONVEY MEANING, WHETHER PLAYFUL, MUNDANE, OR PROFOUND.

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Echoing Egyptian hieroglyphs and composed of 400 separate photographs, this illustration presents a riddle in the form of a rebus. The names of eight pictured objects suggest the sounds of other words that together form a simple declarative sentence. Clues appear throughout the text of this article, where the names of the objects are written in various languages.

...ir Kangri...

Five Thousand Years of Writing

The origin of writing was the need to record the stuff of everyday life. Fussy calligraphy, subway ads, priceless first editions, speedy e-mail—all can be traced to clay tokens, precursors of writing, used to count goods in the Middle East. Found in Iran, a crescent-shaped clay token from the fourth millennium B.C. (above) has been interpreted as representing an ingot of metal, a round token as one sheep.

A leap forward came when a Sumerian picked up a reed and impressed pictures of the tokens into a moist clay tablet: Cuneiform, the first script, was invented. Like points of light blinking on in a dark field, other civilizations developed their own forms of writing. All met a general and commonly used definition: a system of human communication by means of conventional visible marks linked to spoken language.

ORIGINS OF MAJOR WRITING SYSTEMS

3000 B.C. | 2000 | 1000 |

CUNEIFORM was used by speakers of some 15 languages over the course of 3,000 years. The latest datable tablet, written in the city of Babylon, was an astronomical almanac describing planetary positions for A.D. 74-75.

PAPYRUS, made from the reedy plant of the same name, was used as a writing material by Egyptians from at least 2500 B.C., though a blank roll was sealed in a tomb 500 years earlier. With chiseled reed pens, Romans wrote on papyrus into the second century A.D.

PARCHMENT, made from thinly stretched skin of sheep and goats, takes its name from Pergamum, in Asia Minor, where its manufacture was perfected in 190 B.C. for a king seeking a library to rival Alexandria's. A finer calfskin version is often called vellum. Both began to decline in use after the tenth century A.D., when Europe was gradually introduced to a revolutionary product invented in China nearly a thousand years earlier: paper.

Mesopotamian Cuneiform

3200 B.C. TO A.D. 75

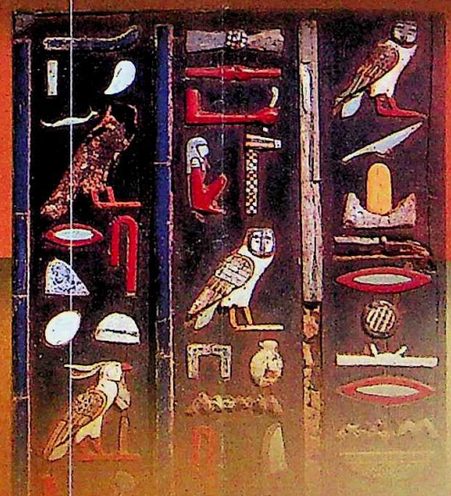
Impressions made in damp clay with a wedge-shaped reed stylus initially recorded lists and administrative accountings, then expanded into historical accounts and literature. Cuneiform spread from Sumer to other Middle Eastern cultures.

A cuneiform tablet found in Iraq recounts how a ruler's wife sacrificed livestock to the gods in 2350 B.C.

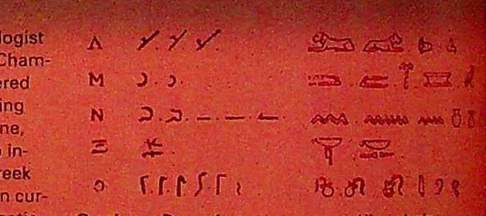
Egyptian Hieroglyphs

CIRCA 3200 B.C. TO A.D. 394

Barely dimmed by the ages, vivid writing adorns a coffin lid from the fourth century B.C. Hieroglyphs can function as either logograms—signs representing things or ideas—or phonograms, in which pictured objects represent sounds.



In 1822 Egyptologist Jean-François Champollion deciphered hieroglyphs using the Rosetta stone, which was also inscribed with Greek and an Egyptian cursive script, demotic.



Chinese Logograms

1200 B.C. TO PRESENT

Dating from the Shang dynasty, the earliest Chinese writings appear on bone or turtle shell (right) that was heated over fire to divine the future. Resulting cracks revealed the answers, which scribes then recorded.

Levantine Alphabets

1050 B.C. TO PRESENT

An alphabet created by Phoenicians is the roots of other writing systems in the eastern Mediterranean, including mod Hebrew and Arabic. Around the sixth cen tury B.C. the Greek alphabet gave rise to the Latin system widely used today.

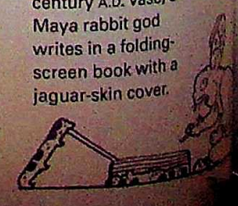
Indus Valley

2800 TO 1900 B.C.

Excavations in Pakistan's Indus River Valley shed light on the trade and crafts of the Harappa civilization. Inscribed seals and other artifacts bearing writing may have served as forms of personal identification, guarded as carefully as today's credit cards.

Harappan writings, from left: early-period button seal, inscribed sherd, two seals with people and mythical beasts, and, below, late-period seal.

Painted on an eighth-century A.D. vase, a Maya rabbit god writes in a folding-screen book with a jaguar-skin cover.



TOKENS MUSÉE DU LOUVRE, PARIS; CUNEIFORM WRITING MARVIN A. POWELL, JR., NORTHERN ILLINOIS UNIVERSITY; TABLET PHOTOGRAPHED BY CICCIONE, RAPHO, AT MUSÉE DU LOUVRE; COFFIN LID EGYPTIAN MUSEUM, CAIRO; TURTLE SHELL PHOTOGRAPHED BY WAN-GO H. C. WENG AT ACADEMIC SINICA, TAIPEI; CHINESE CHARACTERS ART BY KENNETH JOE; HARAPPAN ARTIFACTS, FROM LEFT, PHOTOGRAPHED BY J. M. KENOYER, HARAPPA ARCHAEOLOGICAL RESEARCH PROJECT, AT THE DEPARTMENT OF ARCHAEOLOGY AND MUSEUMS, KARACHI, PAKISTAN; J. M. KENOYER; PHOTOGRAPHED BY JEHANGIR GAZDAR, WOODFIN CAMP, AT NATIONAL MUSEUM OF INDIA, NEW DELHI; NATIONAL MUSEUM OF PAKISTAN, KARACHI; J. M. KENOYER; RABBIT ART BY DIANE GRIFFITHS PECK FROM *BREAKING THE MAYA CODE*, MICHAEL D. COE; MAYA GLYPH YAXCHILAN, MEXICO; LATIN "A" FROM *CHAMP FLEURY*, GEOFFROY TORY, 1529

MAYA SCRIBES painted glyphs on pounded bark with brushes tipped with bird feathers. Chinese calligraphers prized bamboo brushes tipped with hair from the thick autumn coats of martens.

VIRTUALLY all writings in the runic alphabet, used in northern Europe in the first millennium A.D., were incised on wood or stone.

IN THE 1450s Gutenberg's movable-type printing press ignited an explosion of book publishing and literacy.

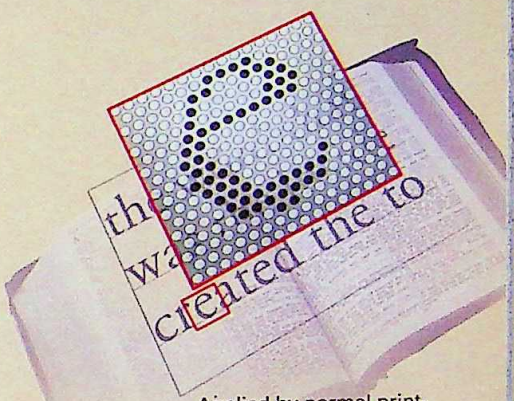
LOUIS BRAILLE, blinded as a child, in 1824 invented the 63-character alphabet read by fingertip.

REMINGTON'S 1874 typewriter was the first to use the keyboard character arrangement still found on word processors today.

A.D.1000 | 2000 |

Chinese script reads, from top: "gold, jade, fill, hall" in archaic seal style, in modern script, and in flowing grass style used for poetry and personal letters. Translation: "hall full of precious things."

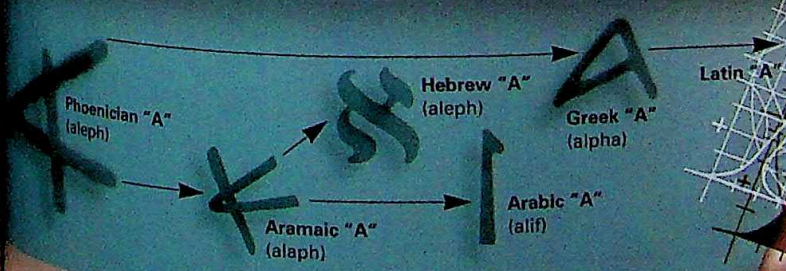
Seal style | Modern script | Grass style

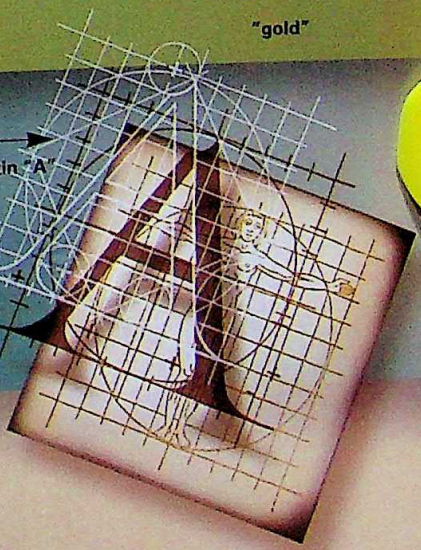


Applied by normal printing processes, E-Ink is composed of microscopic spheres that change color by electronic signal, instantly transforming a book from, say, *Moby Dick* to *Huckleberry Finn*.

Computerizing Chinese: To create this character on a Latin-alphabet computer keyboard requires four strokes—four strokes fewer than if written by hand.

"gold"





Maya Hieroglyphs

A.D. 250 TO 900

The Maya wrote dates in symbolic figures. On a stone lintel a monkey representing a day holds a head denoting the number 6 above a skull standing for 10, signifying 16 days.

ART BY ALICIA BUELOW; TITLE CALLIGRAPHY BY JULIAN WATERS; REBUS CLUE CALLIGRAPHY BY MARK VAN STONE

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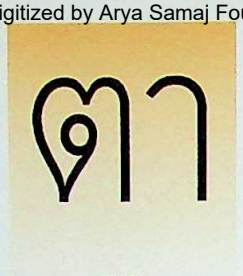

THAI
"eye"

Pinpoint precision and steadfast devotion guide the hand of Rabbi Akiva Garber (below), a Torah scribe in Jerusalem. Copying a Torah, the five Books of Moses, can take more than a year and is governed by hundreds of laws. A worn-out Torah is put to rest in a ceremony not unlike a funeral.

At Jerusalem's Western Wall, a young man attending a bar mitzvah wears passages from the Torah coiled inside a leather box called a tefilla. Jews who wear such phylacteries follow the dictum from Exodus calling on males to wear "a memorial between thy eyes."

CHINESE STATE SECURITY OFFICERS *arrested Wei Jingsheng, an electrician, on March 29, 1979. Among his major crimes: writing essays arguing for democracy. Wei, who would spend 18 years in jail and become a prominent symbol of the power of the written word, was placed in the Beijing detention center.*

Chinese authorities feared Wei, recognizing that writing has an almost magical power: Words on paper, created by ordinary citizens, have overthrown governments and changed the course of history. So powerful is writing that the beginnings of civilization and history are most often defined as the moment cultures develop it. Anthropologists can only paint outlines of ancient societies that had no writing; a written record provides the human details—history, belief, names and dates, thought, and emotion.

No other invention—perhaps only the wheel comes close—has had a longer and greater impact. Writing helped preserve the three major monotheistic religions, whose believers the Koran refers to as "the People of the Book." The transformation of language into written words has immortalized passion, genius, art, and science—the letters of St. Paul, the poems of Li Po, the humor of Aristophanes, the treatises of Maimonides.

Much of writing's power comes from its flexibility. Ever since the Sumerians began keeping records by impressing cuneiform signs on clay tablets 5,000 years ago, humans have searched for the ideal tools to portray words. They have chiseled symbols in stone and bone and have written on leaves, bark, silk, papyrus, parchment, paper, and electronic screens. This skill, once known only to a few professional scribes, grew into mass literacy: Some five billion people can read and write today, about 85 percent of the world's population.

From its beginning as recordkeeper to its transformation into one of humanity's most potent forms of artistic and political expression, writing reveals the power of innovation.

But the story of Wei proclaims writing's greatest power—its ability to move hearts and minds.

His cell measured four and a half feet by nine feet. Authorities kept the light on at all times. No one, not even his guards, was allowed to speak to Wei, and he was not permitted to read or write. His requests for paper and pencil were ignored.

To understand how writing evolved, I visit Sarabit el Khadim, a flat-topped, wind-eroded mountain of reddish sandstone in the southwestern Sinai Peninsula of Egypt. Here, in a turquoise mine dug by Egyptians almost 3,500 years ago, is one of the earliest examples of a phonetic alphabet. Avner Goren, an Israeli archaeologist who supervised excavations in the Sinai for 15 years, is leading me up a steep

CARY WOLINSKY's article and photographs on color appeared in last month's issue.

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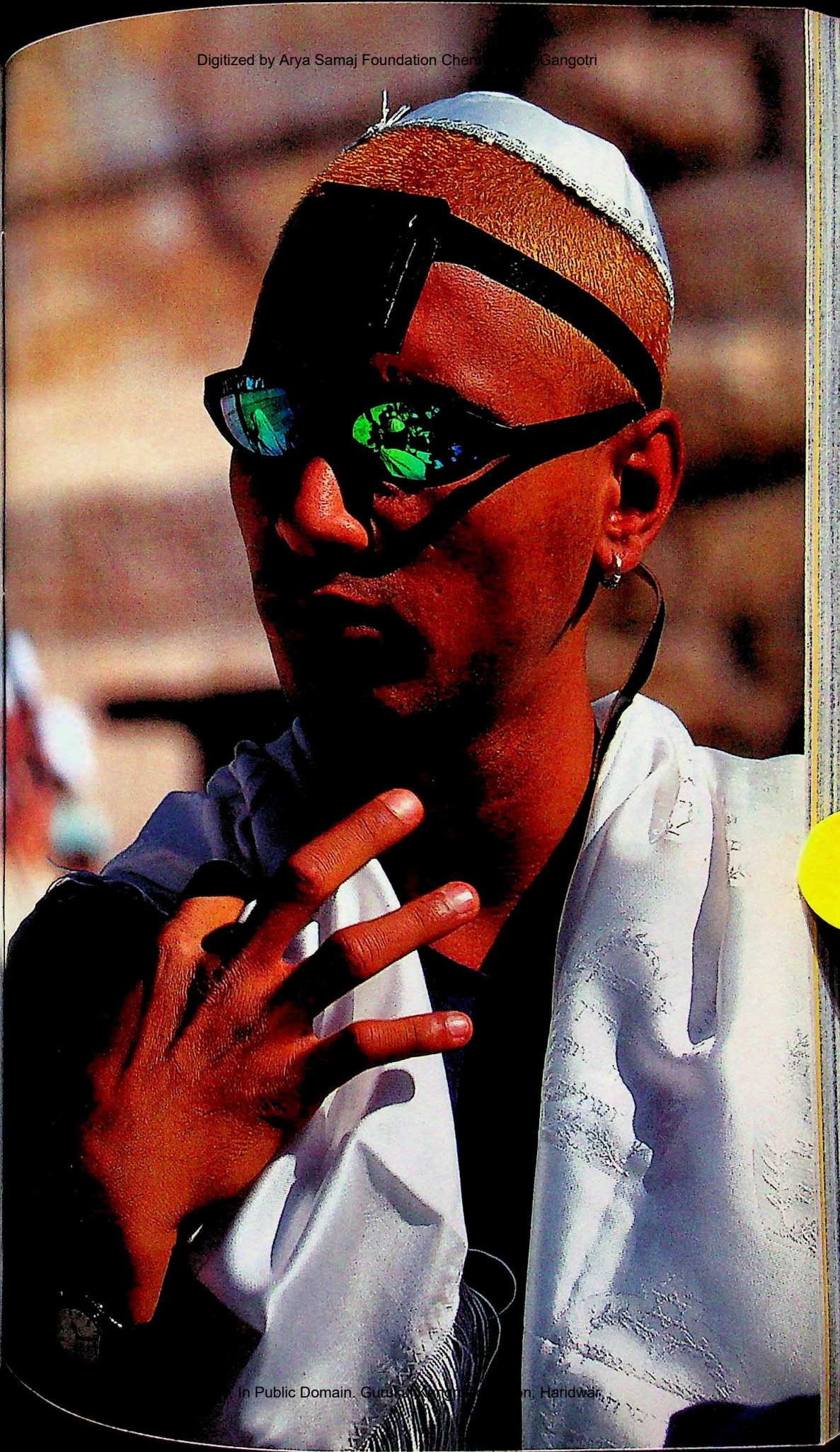

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trail, with narrow ledges and a drop-off to rocks far below. Near the top, we stoop to enter a dark hole.

"What do you think?" Goren asks, pointing to a wall about six feet in front of us. Carved into the stone are crude sketches of a fish, ox head, and square, remarkably different from the Egyptian hieroglyphs found elsewhere at the site.

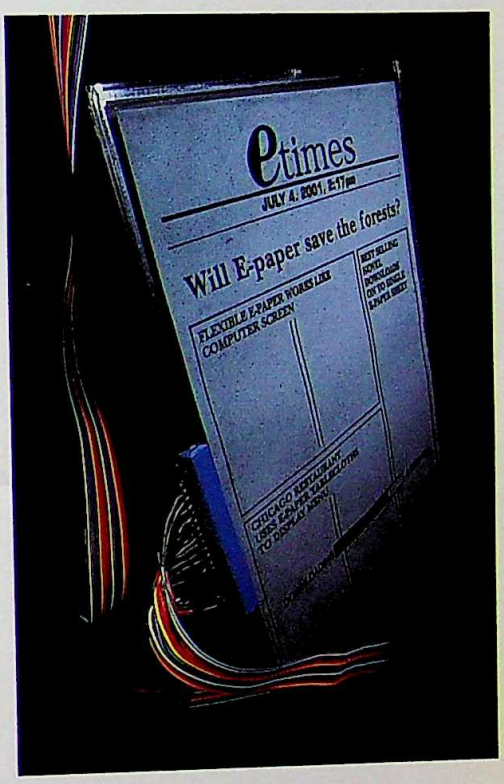
The simplicity of these marks belies their significance. I move closer, as if proximity will reveal their magic. The people who made these signs were among the first to use characters each of which represented one sound—an alphabet. These alphabetic symbols had acrophonic values, with each representing the initial sound of the object depicted. The picture of the square—a house—thus stood for the *b* sound because the word for house was *beit*.

If these ancient writers were not Egyptians, who were they? After British archaeologists explored Sarabit el Khadim in 1905, some scholars argued that they were Israelites fleeing from Egypt with Moses about 1250 B.C. But similar writing as old or older was discovered in present-day Israel in the 1930s, so most researchers now believe that this alphabet was invented in Canaan, a region between the Jordan River and the Mediterranean Sea. Most likely, Canaanites who were brought in to work the mines left these messages.

MIXTEC PICTOGRAM
"bee"

Egyptian scribes had to master hundreds of symbols. I tell Goren that alphabetic writing must have seemed much more attractive to those scribes. "Probably not," he says. "About 30 of the symbols in Egyptian hieroglyphs represent single sounds, just like the alphabet. They knew about using symbols to represent sounds. To the Egyptians the Semitic writing may have looked too primitive to be significant."

That night, as we lie in sleeping bags at the base of the mountains, Goren warns against seeing an alphabet as "superior" to pictographic writing. "If you came from outer space and wrote a report, you'd give the alphabet high marks," he says. "It's flexible and easy to learn. But



Sacred duty awaits a calf skin processed in Jerusalem as parchment for a Torah, each sheet of which is made from a separate animal. Precious in its own way, the chained library at England's Hereford Cathedral holds more than 200 one-of-a-kind medieval manuscripts.

Readers may someday use tree-saving electronic paper being developed by Xerox (above). Sheets are filled with bicolored microscopic balls: one hemisphere with a positive charge, the other with a negative charge. Voltage flips the balls, creating text pages that can be reprogrammed at will.

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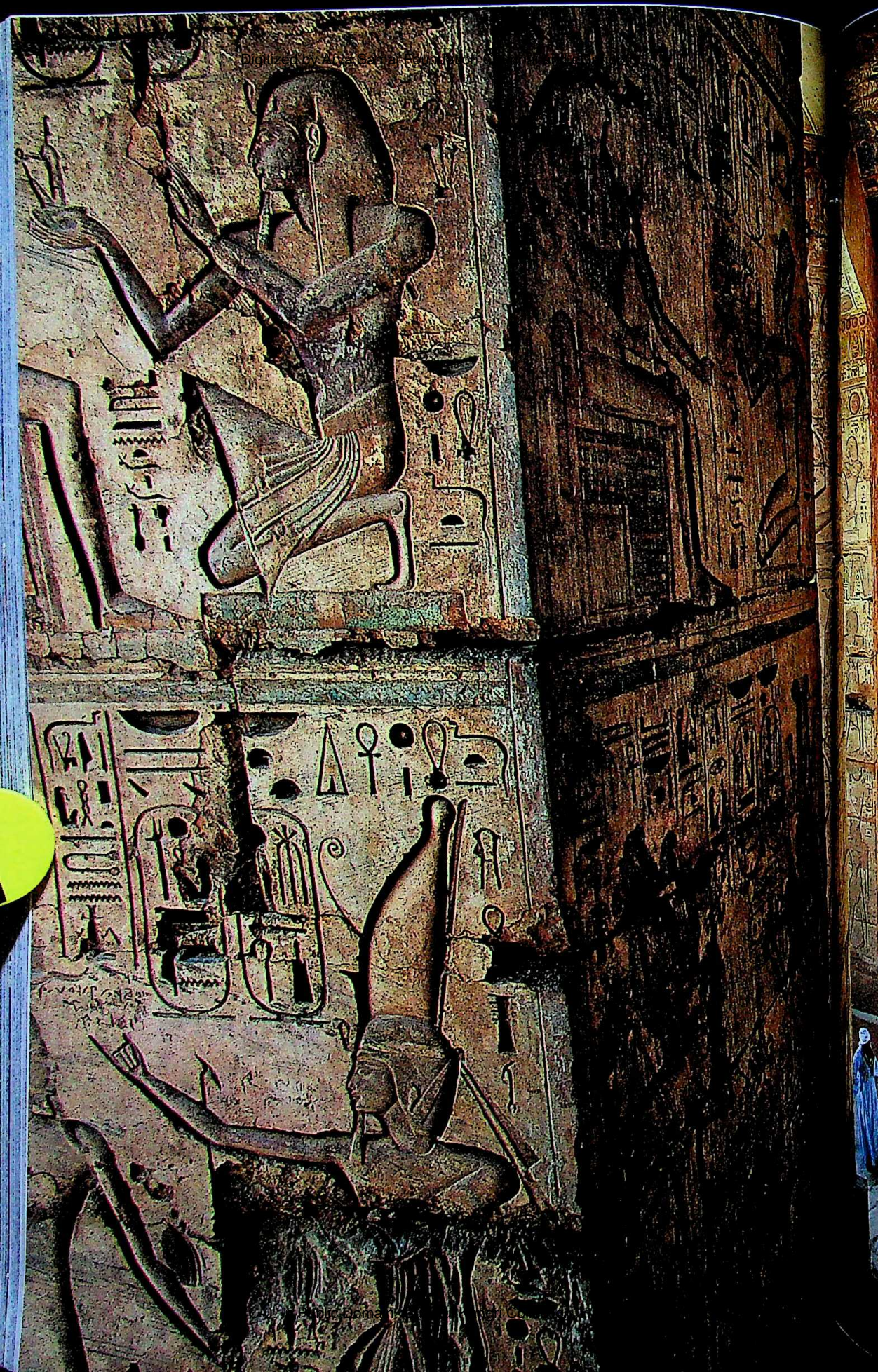

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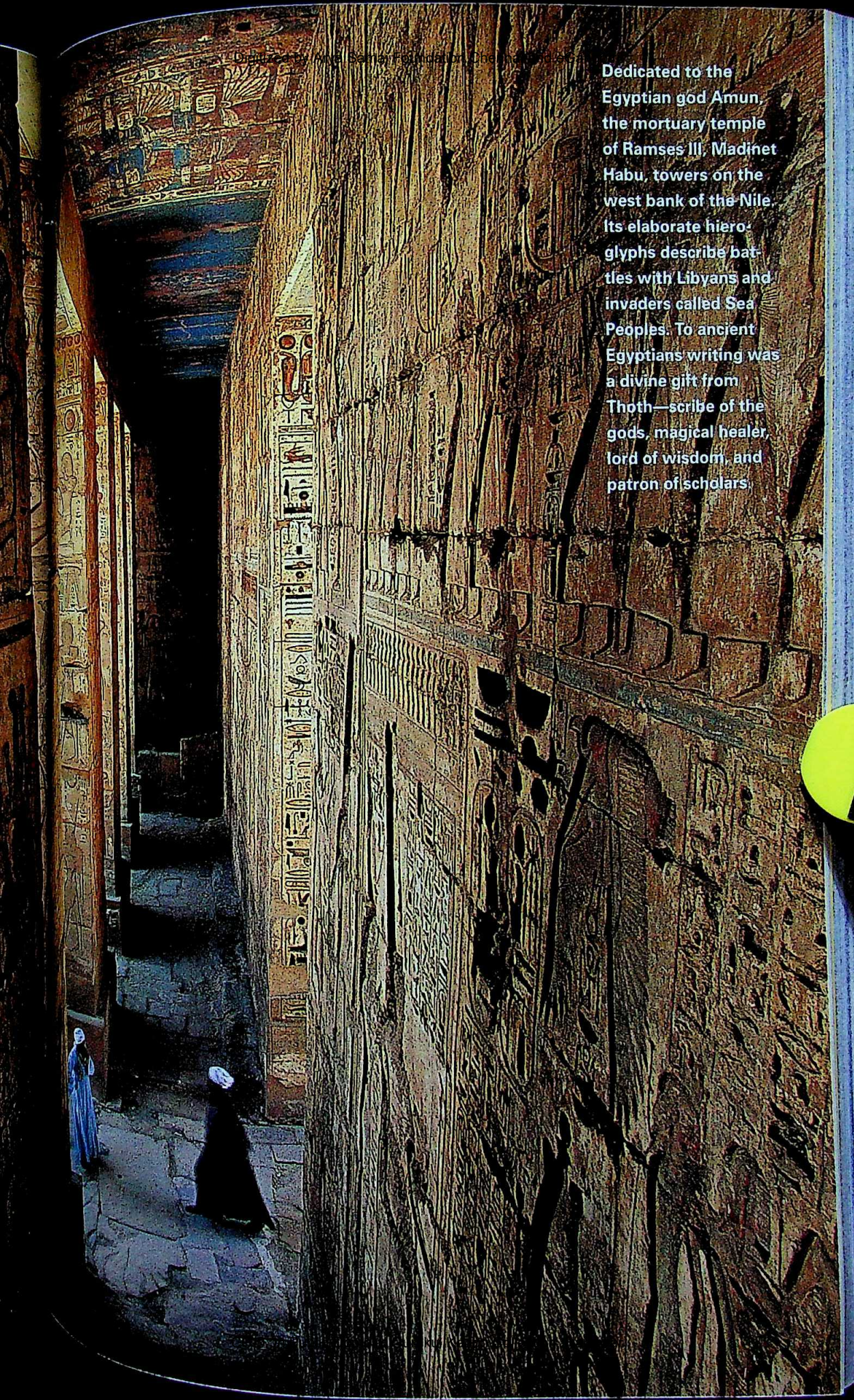

Dedicated to the Egyptian god Amun, the mortuary temple of Ramses III, Madinet Habu, towers on the west bank of the Nile. Its elaborate hieroglyphs describe battles with Libyans and invaders called Sea Peoples. To ancient Egyptians writing was a divine gift from Thoth—scribe of the gods, magical healer, lord of wisdom, and patron of scholars.

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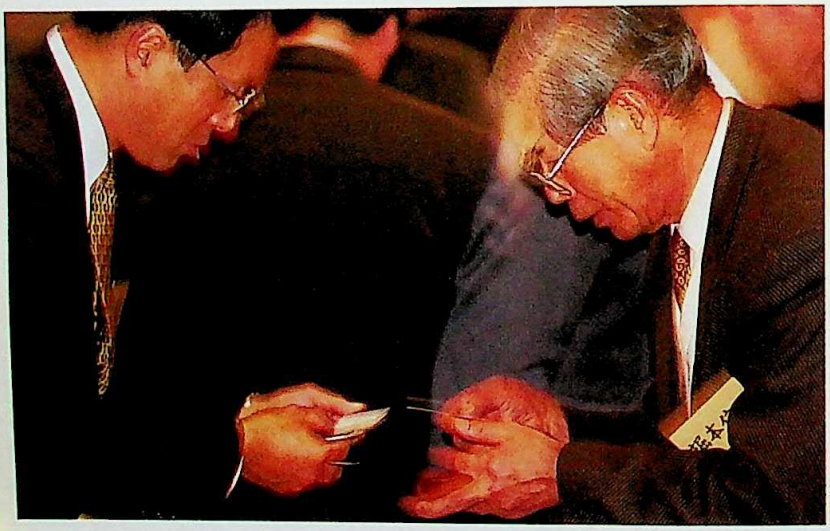
what actual effect did that have? There was no mass literacy until after the development of the printing press in the mid-15th century."

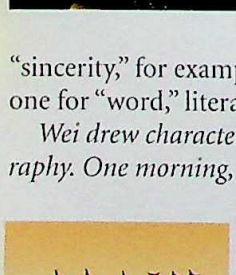
But alphabets, it seems to me, changed the way people thought. Theoretical science, formal logic, and the concept of time as a straight line moving from past into future came from societies with alphabets.

From a small patch in the Middle East the notion of one symbol per sound spread around the world, taking root first among the Greeks, who modified some characters into written vowels. The Latin alphabet of the Romans evolved from the Greek around the sixth century B.C. By the ninth century A.D., Japan had developed strong phonetic components in its written language; Korea by the 15th. Indeed, of the several hundred written languages in the world today, only Chinese still relies on a writing system in which individual characters represent individual words. These characters often mean one thing when used alone, but something else when combined. The Chinese character for



"sincerity," for example, shows the character for "man" alongside the one for "word," literally a man standing by his word.

Wei drew characters in his head, taking pride in this mental calligraphy. One morning, more than two years after he was placed in solitary confinement, his food tray included a ballpoint pen—another prisoner or a sympathetic guard had smuggled it to him.



NORSE RUNES
"leaf"

Wei began to write letters to his family on the rough sheets he had for toilet paper. Guards found these letters and demanded to know where he had hidden the pen. Wei refused to say. After guards failed to find the ballpoint, which Wei had tied to a string and lowered inside the hollow metal rods of his bed, the warden ordered him to another cell. Wei sneaked the pen with him.

Since writing's invention, people have used it to combat loneliness and establish a sense of self. In the fourth century B.C., Aristotle saw writing as a way to express "affections of the soul." Recent studies have documented that writing about feelings can alleviate depression, boost the immune system, and lower blood pressure.

Complexities of Japanese confront second graders in Kyoto, where students write some of the 200-plus characters for the sound "shou." The language commonly uses 15,000 kanji characters, which are borrowed from Chinese. Because so many words are homophones—the same sound but a different meaning—exchanging business cards is an absolute necessity to know the spelling of a Japanese name.

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How, then, do people in societies without writing express themselves? Of the more than 10,000 languages ever spoken, most had no written form. "We talk to each other, listen, visit, and trust the spoken word," says Guujaaw, a leader of the Haida Nation. "Expressing yourself without writing is natural."

The Haida have lived on the Queen Charlotte Islands off the coast of British Columbia for more than 10,000 years. Guujaaw and I are walking on Sgan Gwaii, a small island in the south that has some of the world's last temperate rain forest. Mosses and ferns cushion our steps. In the ocean, sea lions and puffins dive for fish.

"Like most other cultures in the Western Hemisphere, you never developed writing until outsiders brought it in," I say. "Do you think that's because you had no need for writing?"

"Are you suggesting that writing is better than speaking?" Guujaaw asks in response to my question.

The answer seems obvious, I say. Things get distorted when people repeat them to one another, especially over long periods of time.

"Things get distorted in writing as well," he says. "Oral histories from our people go back thousands of years. They are a living history. They provide a link between storyteller and listeners that written

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stories cannot. In fact, human intimacy and community can best come through oral communication."

Guujaaw leans on a rock. "I'll tell you a Haida story," he says. "Don't write it down. Listen. If you are busy writing, you will miss half the story. A story includes the telling and the listening."

Hearing his story about how animals warn humans not to spoil the water stimulates my senses. Guujaaw's voice, the breeze, the ocean, and the trees around us all flow through me. If I were reading the story, I would be alone in another world—and much less aware of my surroundings.

عين

ARABIC
"eye"

Plato would have said, "I told you so." Living at a time when writing began to challenge Greece's oral-based culture, he warned that writing would make people "trust to the external written characters and not remember of themselves. . . . They will be hearers of many things and will have learned nothing."

But Plato lived in the fifth century B.C., when reading was physically difficult. Books were papyrus scrolls often more than 60 feet long; the idea of pages, sparked in large part by the availability of parchment, emerged in Europe in the second century A.D. Space between words did not become standard in Western society until the seventh century. Long after Plato's time, writing served mostly as an aid to memory, something to stimulate the spoken word. People read aloud, a practice that died slowly. St. Augustine, one of the world's leading scholars in the fourth century A.D., was shocked to come upon his mentor St. Ambrose reading silently.

This transition from the spoken to the written word occurred because writing meets certain needs so much more effectively. Writing permits analysis, precision, and communication with future generations in a way not possible via the spoken word. The only way I know about St. Augustine's experience is that he mentions it in a book.

Still, Plato was right—people in an oral culture need strong memories. I have forgotten most of Guujaaw's story by the time we enter Ninstints, an old Haida village.

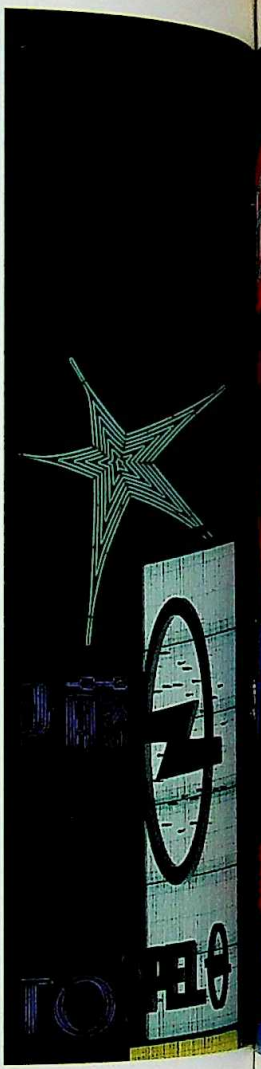
Ninstints was home to hundreds of Haida families in the mid-19th century, before white people landed. Now all that remains are the foundations of a few houses and some rotting totem poles. Today there are only about 4,000 Haida compared with 40,000 in the 19th century.

Despite such decline, Guujaaw insists that the Haida have not been defeated by people with writing. "We've been here on this land for thousands of years, and we're still here," he says. "Writing is not essential to living. People with writing are a brief chapter in our history."

But Native American oral culture worked best when people went on long hunting or fishing trips and gathered around campfires every evening. Now modern devices like television discourage the sharing of oral traditions.

Days later I share this thought with Pansy Collison, a Haida who teaches high school in Prince Rupert, British Columbia. "Don't forget that oral history is an essential part of our students' identity," she says.

Collison uses storytelling in the classroom to help her students learn their history and build pride in who they are. As part of this, her



Shouting their messages, colossal neon signs light the night in Tokyo's glitzy Ginza shopping district. Some business leaders believe that using the Latin alphabet in advertising lends prestige to their corporations. While many Japanese can read English, relatively few can write or speak it.

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students write out the oral traditions of their family or clan—she relies on writing to preserve oral history.

As Collison shows me how these written lessons help invigorate oral traditions, I realize I am seeing another example of writing's extraordinary flexibility. Most Native Americans lost ground to outsiders who had weapons and machinery that developed only in societies with writing. But now writing is vital to the Haida's rejuvenation.

In the winter of 1981, after holding Wei in solitary confinement for more than two years, authorities realized they could not keep him from writing. They gave him a new ballpoint pen and better paper and authorized one monthly letter to his two sisters and brother.

In these letters Wei discussed art and offered advice on romance. He was forbidden to write about being beaten or deprived of sleep. He also could not mention his malnutrition, headaches, heart pain, diarrhea, and rotting teeth.

Wei never knew if his letters were delivered. He told his fiancée to find someone else, not knowing that she had already married.

Authorities also told Wei to write to government officials explaining his crime: trying to break up China. He did write to officials but told them they threatened national cohesion by suppressing freedom.

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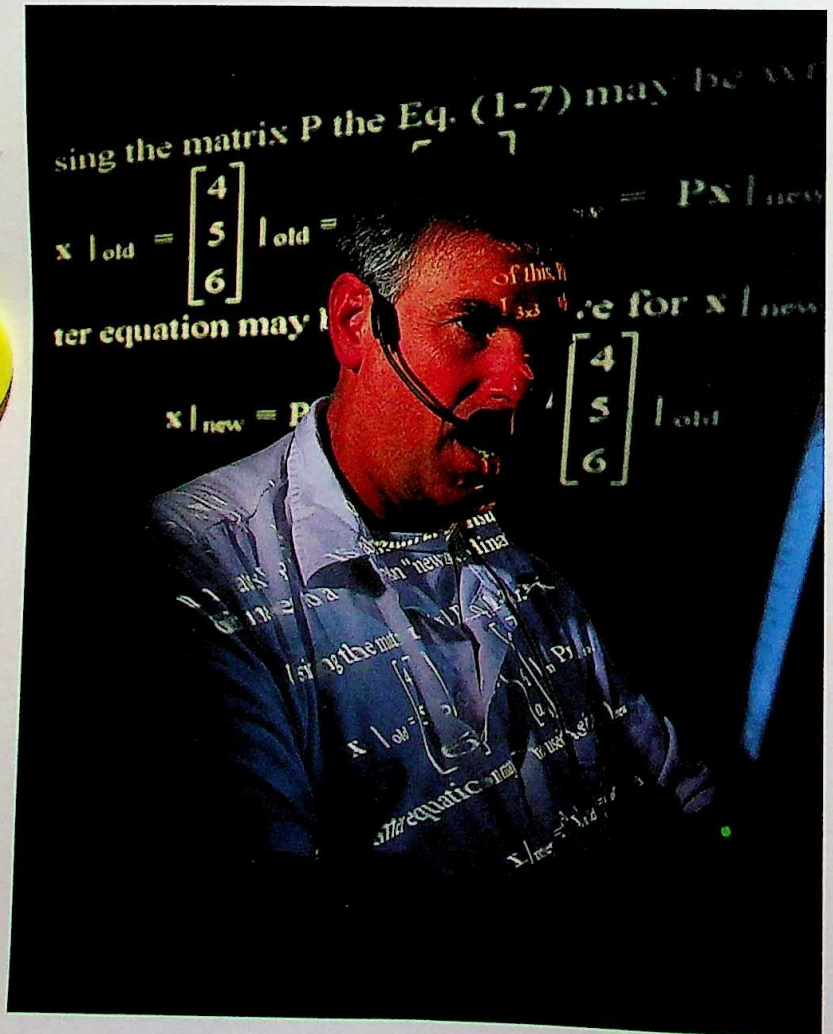
Maintaining national cohesion has always been a prime concern for China's rulers, who learned thousands of years ago that sharing the same written language can unite people. In the third century B.C. Chinese people spoke at least eight languages and countless dialects, but with establishment of a unified empire and a standard system of writing around 200 B.C., everyone could read the same characters.

罐

CHINESE
"can"

Joseph Stalin, who ruled the Soviet Union from 1928 to 1953, was a master of using writing to control people. Russia and Persia had divided Azerbaijan in the early 1800s. Shortly after taking power, Stalin feared the Azerbaijanis' loyalty to their countrymen in neighboring Iran, formerly Persia. Hoping to divide the two groups, he encouraged the Soviet Azerbaijanis to emulate nearby Turkey and switch from the Arabic alphabet to the Latin alphabet.

By the 1930s Stalin, concerned about growing ties between Turkey and Azerbaijan, forced the Azerbaijanis to adopt Cyrillic, a script used for writing Russian and other Slavic languages. It had evolved from a script created by missionaries of the Orthodox Church in the ninth century A.D.



Bypassing mechanical typing, Gary Reid writes straight from the mind. A former varsity swimmer who lost his motor skills to multiple sclerosis, Reid uses software that translates his voice into characters. In his Hollis, New Hampshire, home he prepares a new edition of his engineering textbook, *Linear System Fundamentals*. Photographer Wolinsky used projectors to cast

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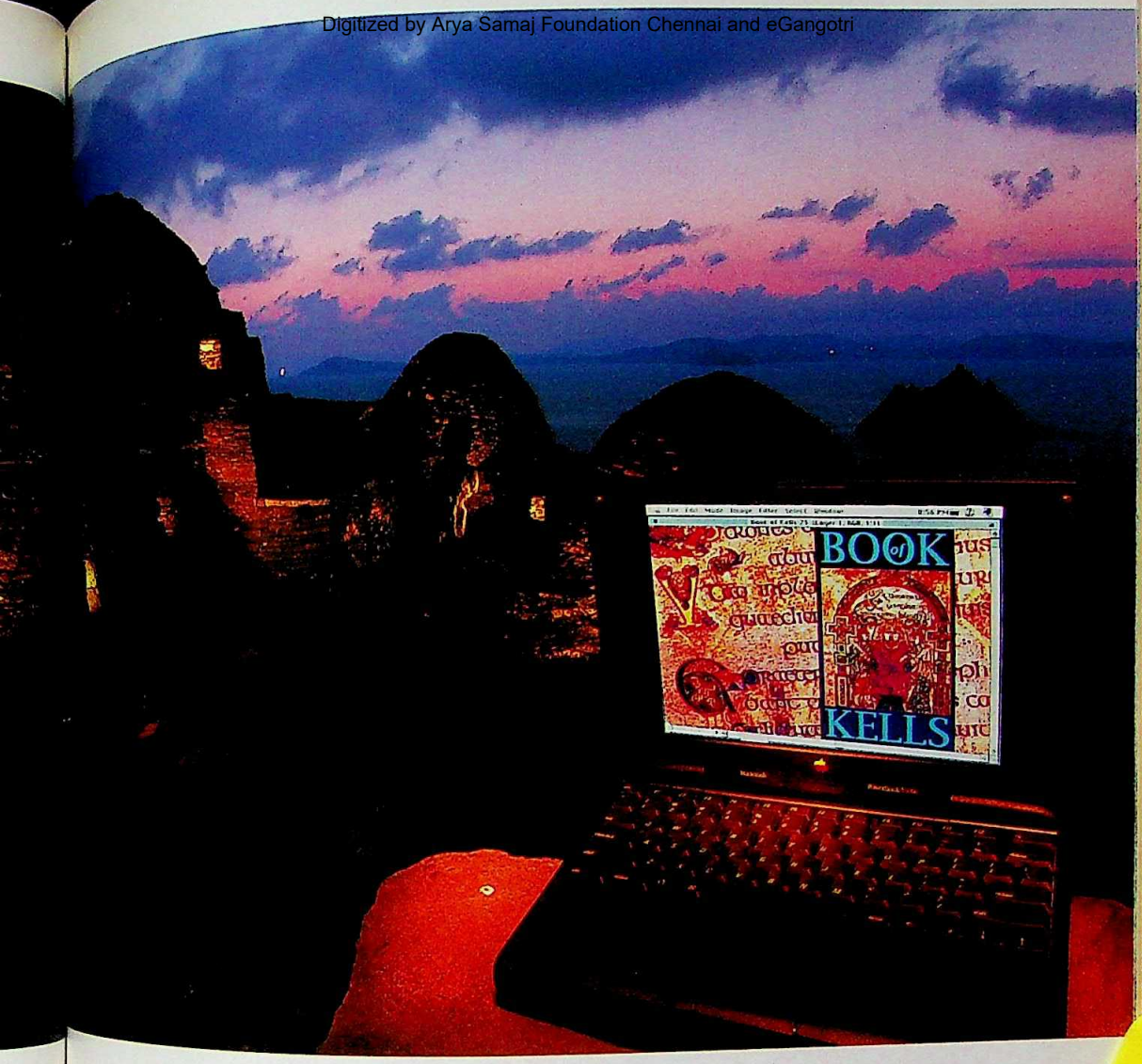

formulas onto Reid and his bedroom wall.

At Ireland's Skellig Michael monastery, Wolinsky's computer displays a website page from the *Book of Kells*. Kept at Trinity College, Dublin, the illuminated manuscript was housed at Kells, one of the Irish monasteries that preserved classical Greek and Roman writings by copying manuscripts during the Dark Ages.

This alphabetic clash seems alive as I walk through Baku, Azerbaijan's capital. Newspapers are in Cyrillic, labels on canned food are in the Western Latin alphabet or in the Turkish-style Latin with its umlauts and cedillas, and street signs are in freshly painted Azerbaijani Latin, which has "x," "ə," and "q," letters not found in the Turkish alphabet. There is no sign of Arabic letters.

"We chose Latin letters largely because they will help us be modern and will link us to the rest of the world," Oruj Musayev, professor of English at the Azerbaijan State Institute of Languages, tells me. Musayev has just finished compiling the first Azerbaijani–English dictionary using Latin letters. "Our alphabet choice reflects geopolitics. Dropping Cyrillic meant moving away from Russia. Although we're Muslim, we're nonsectarian, so we didn't want to use the Arabic alphabet, which would link us to the mullahs in Iran."

The stakes are high. Azerbaijan has promising oil reserves and is courting Western buyers.

That the West relies on the Latin alphabet is a remnant of the Roman Empire. Latin letters have endured because they serve Western languages well—and using Latin letters has become associated with being "modern."

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Eyes only: Developed by the U.S. Central Intelligence Agency, paper that dissolves in water (below) allows operatives to read and then quickly destroy covert messages.

A logo designed for Nike athletic shoes also proved less than permanent. Muslims objected to the stylized word "Air," which they felt resembled "Allah" in Arabic script and was disrespectful when used on shoes. Nike apologized, calling the design an innocent mistake and pulling the shoes from distribution.

The Latin alphabet's connection to the outside world becomes evident the next day when I drive to Lahic, a village isolated in the Caucasus Mountains. In addition to Azerbaijani, people in Lahic speak a dialect of Persian found nowhere else, which has no written form.

Aga Ismailov, a farmer at the edge of town, invites me for a special lunch. As Ismailov barbecues a lamb he slaughtered the day before, his children prepare plates of tomatoes, cucumbers, watermelon, cheese, and freshly baked olive bread.

CUNEIFORM SIGN
"reed"

"My youngest son is learning French and English in school," Ismailov says, speaking in Azerbaijani. "He is the only one in the family who knows the Latin alphabet."

He asks his son, nine-year-old Bakhish, to join us. "Good afternoon, how are you?" Bakhish says in English. He then shows me how he writes his lessons.

As Bakhish writes, I'm struck by the frequency of the upside-down *e* that I'd noticed all over Azerbaijan. Why select the Latin alphabet because it is used in most international trade and computer transactions and then give yourself a letter no one else has?

"It's the sound somewhere between *a* and *e*, like 'hat' and 'cat,' and is the most common sound in our language," Anar Rzayev, one of Azerbaijan's leading writers and a member of parliament, explains the next day in Baku. "What you call the upside-down *e* dates back to early in our history. We kept it even when we had the Cyrillic alphabet. Maybe it's stubbornness, but it's a symbol of Azerbaijan." Shortly after independence, he says, Azerbaijan's parliament debated eliminating the ə but decided to keep it.

Azerbaijan is a newly independent country with tremendous problems. Development of oil resources is still a dream, and the country's annual per capita income is about $500, making it one of the world's poorest nations. To have its own alphabet seems a strange indulgence.

"There's nothing new about what's happening in Azerbaijan," Anar says. "An alphabet is a symbol of a country just like a flag. Why do you think different alphabets have appeared in the first place?"

Pride in his nation's writing system helped give Wei his Chinese identity. That most Chinese written characters have remained essentially unchanged for more than 2,000 years provides an emotional and a practical tie to the past.

Many of his letters were to China's leaders, whom he criticized. As punishment, authorities sometimes took away the pen they had given him, but other prisoners took apart pens, often stolen from guards, and smuggled them to Wei.

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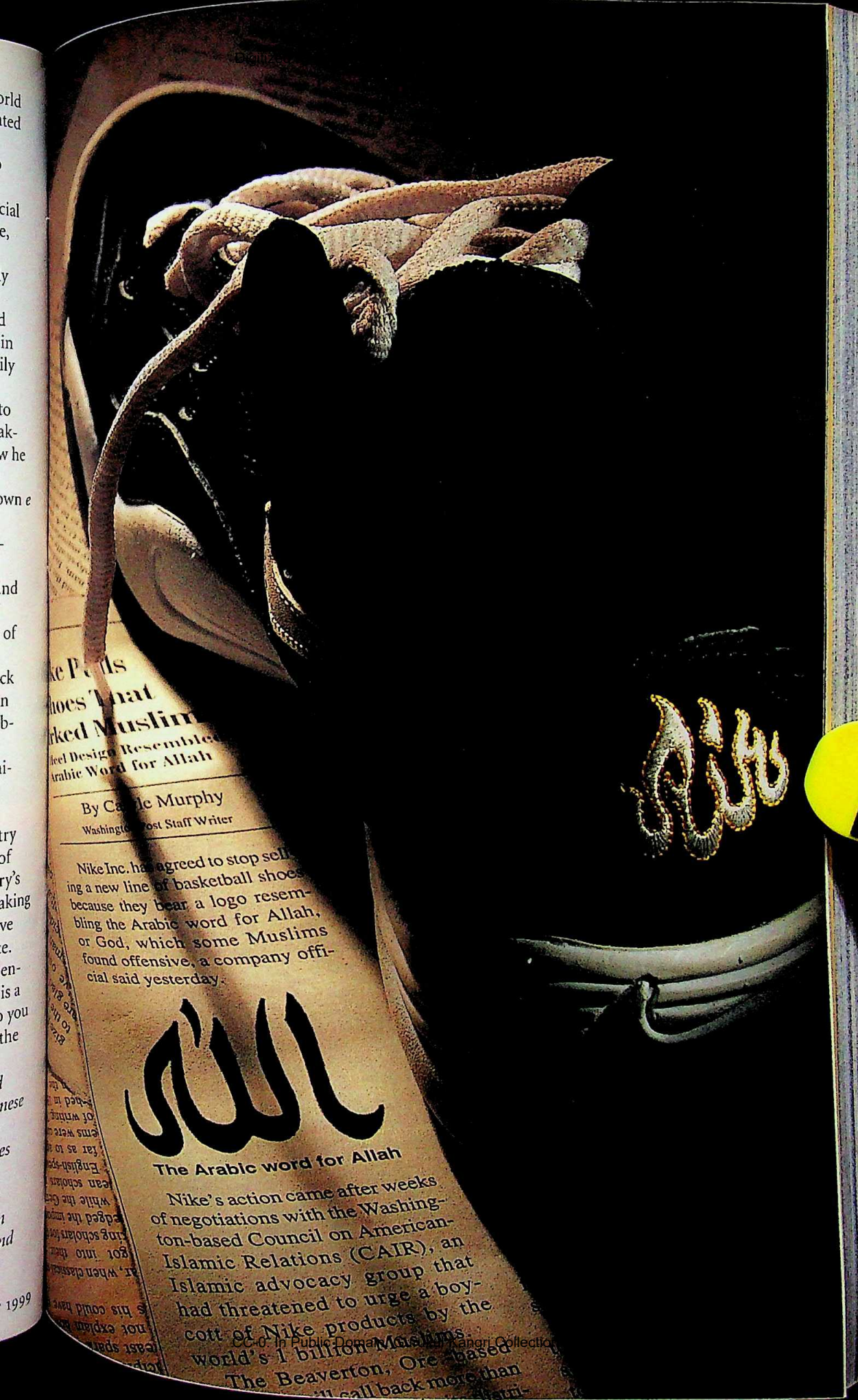

ke P ds
hoes That
rked Muslim
feel Design Resembles
Arabic Word for Allah

By Ca le Murphy
Washingt ost Staff Writer

Nike Inc. ha agreed to stop sell-
ing a new line of basketball shoes
because they bear a logo resem-
bling the Arabic word for Allah,
or God, which some Muslims
found offensive, a company offi-
cial said yesterday.

The Arabic word for Allah

Nike's action came after weeks
of negotiations with the Washing-
ton-based Council on American-
Islamic Relations (CAIR), an
Islamic advocacy group that
had threatened to urge a boy-
cott of Nike products by the
world's 1 billion Muslims.
The Beaverton, Ore.-based
...ll back more than

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"Why write?" the guards asked. "No one will ever see them."

In late 1993 authorities told Wei he would be released. They were trying to win international support for acting as host of the year 2000 Olympic Games. Wei, who had been in jail for nearly 14 years, refused to leave his cell without copies of his letters. "They've been lost," he was told.

"You can find them," he replied. Twelve hours later, the warden returned with his letters.

Six months later, after the Olympic Committee rejected China, Wei was re-arrested. State security seized his papers but failed to find the computer disks onto which his letters had been transcribed.

Tong Yi, the young woman who transcribed Wei's letters onto computer disks, had extraordinary courage. She also had to master the Latin-alphabet keyboard, which requires up to five keystrokes for one Chinese character.

The extra work needed to enter Chinese into a computer raises an important issue. China may become the wealthiest country in the world; it already is a major factor in the international economy. As this economy relies more on computers, does the Chinese writing system put it at a disadvantage?

Usama Fayyad, a senior researcher at Microsoft Corporation, whose job is to think about the long-term future of computers and data storage, says technology will eventually offer efficient and economical ways to bypass keyboards. Voice and handwriting recognition, he tells me, could make it irrelevant which writing system is used. We're in an office on Microsoft's 260-acre campus near Seattle. A painting of clouds floating through a blue sky covers one wall.

MAYA GLYPH
"plate"

Fayyad also says that the distinction between an alphabet and Chinese characters does not matter in terms of how a computer operates. He explains that when you hit a letter on the keyboard, the computer enters that action into its memory as a number. Each letter is a different number, and a sentence inside the computer is a string of numbers. It's up to the computer program to interpret the string of numbers as instructions.

Fayyad warns me not to get too romantic about computers. "They're great at bookkeeping," he says, "but not yet great at recording impromptu ideas, thoughts, feelings. For that, paper is still far superior. You can hold it, fold it, put it in your pocket, look at it again later when it's convenient."

Fayyad's praise of paper leads me to Joseph Jacobson, a professor of physics at the Massachusetts Institute of Technology. He helped found a company, E-Ink, whose technology is trying to transform ink from a permanent medium to something that can change electronically.

"Paper is fantastic," Jacobson tells me as we tour E-Ink offices in Cambridge, Massachusetts. "If books or newspapers on paper had not already been invented, if we lived in a world only with computer screens, then paper would be a breathtaking breakthrough. But the way we use paper is incredibly wasteful."

Jacobson shows me the E-Ink technology he hopes will someday supplement ink on paper. It prints electronic letters on squares of plastic that can be erased and reused.

No keyboards clack as deadline approaches at the *Daily Tej* in Delhi, India. Editor Peter Masih (above, at right) reads English-language news stories from a wire service and rewrites them in Urdu. Calligraphers copy his translations into the artful script of the language spoken by 37 million Indians. Pasted up, the stories are photographed for printing on an offset press.

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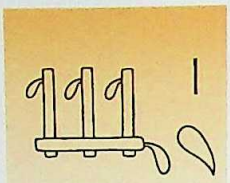
"There's a great thirst for the written word in China," says photographer Wolinsky. In Chengdu (facing page) children rent books from a street vendor.

Proud author Carmen Craig (below) holds a story she wrote for her Brookline, Massachusetts, kindergarten class, which is just learning to read. With today's endless audio-visual onslaught, it may be easy to overlook this recurrent miracle: a child's first act of writing—putting thoughts and emotions on paper.

I ask Jacobson why he uses plastic. "Paper tears too easily," he replies. "We're working on a plastic substance that looks and feels like paper. You could photocopy it, even underline on it with a special pen."

"Isn't that a lot of trouble to solve a problem that doesn't exist?"

"A problem does exist," Jacobson says. "Paper needs to be taken into the digital age. We need writing that changes on paper. Think about all the information people download from the Internet. They don't want to read it on a computer screen, so they print it on paper. The demand for paper is soaring. Think of all the savings in cost and the pollution prevented if you needed less paper."

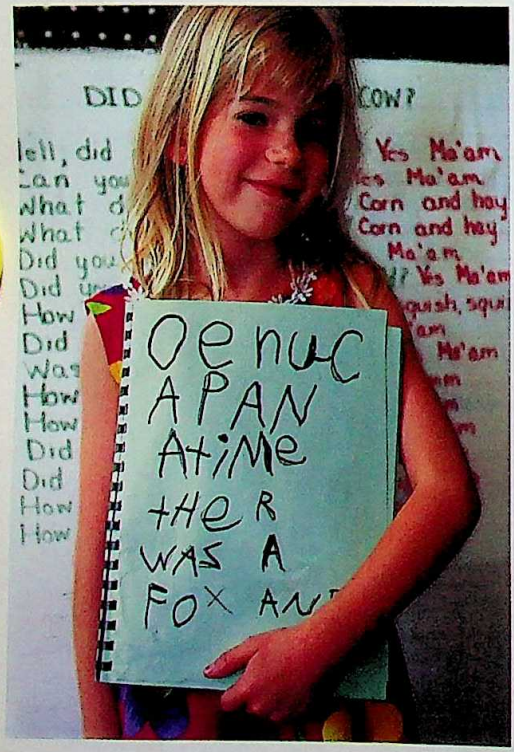


EGYPTIAN HIEROGLYPHS "toe"

As I watch the E-Ink letters blink, I feel as if I'm back in the cave at Sarabit el Khadim—looking at a piece of the future.

After Wei's re-arrest in 1994 he was placed back in solitary confinement. Two walls of his new cell were glass, so constant monitoring could ensure he did not write. For more than six months not even his family knew whether he was dead or alive. In 1997 a book of Wei's letters, The Courage to Stand Alone, *was published in the United States. Tong Yi, who transcribed his letters, had been sentenced to two and a half years in a labor camp. After serving this time, during which she was sometimes beaten, she was allowed to leave China.*

In the summer of 1997 I read *The Courage to Stand Alone* and follow news accounts of Wei's treatment. He is frequently beaten and denied adequate health care. I fear he will die soon.



Then in November 1997 the Chinese government releases Wei, largely in response to international pressure, and puts him on an airplane to the United States. A few weeks later I meet him at his office in the Center for the Study of Human Rights at Columbia University.

I am startled by Wei's smile and how well he looks. He explains that he can eat only soft food until his teeth are fixed, and sips tea as we talk.

"Writing," he says, "kept me alive. I sometimes thought about a letter for a week before writing anything. It's something that you must do even if you do not have the leisure of being in prison. To write, you must work methodically, forming your thoughts and prompting other people to think as they read. Writing requires work at both ends. That's what makes it special."

Wei plans to write a book about the experiences, feelings, and ideas he could not put in his letters, which he knew would be read by prison officials.

"I wish I could read it in Chinese," I say.

Wei laughs. "You can learn," he says, writing 友谊.

"It means 'friendship,'" Wei says.

Add another dimension to the power of writing by joining our online forum at *www.nationalgeographic.com/ngm/9908.*

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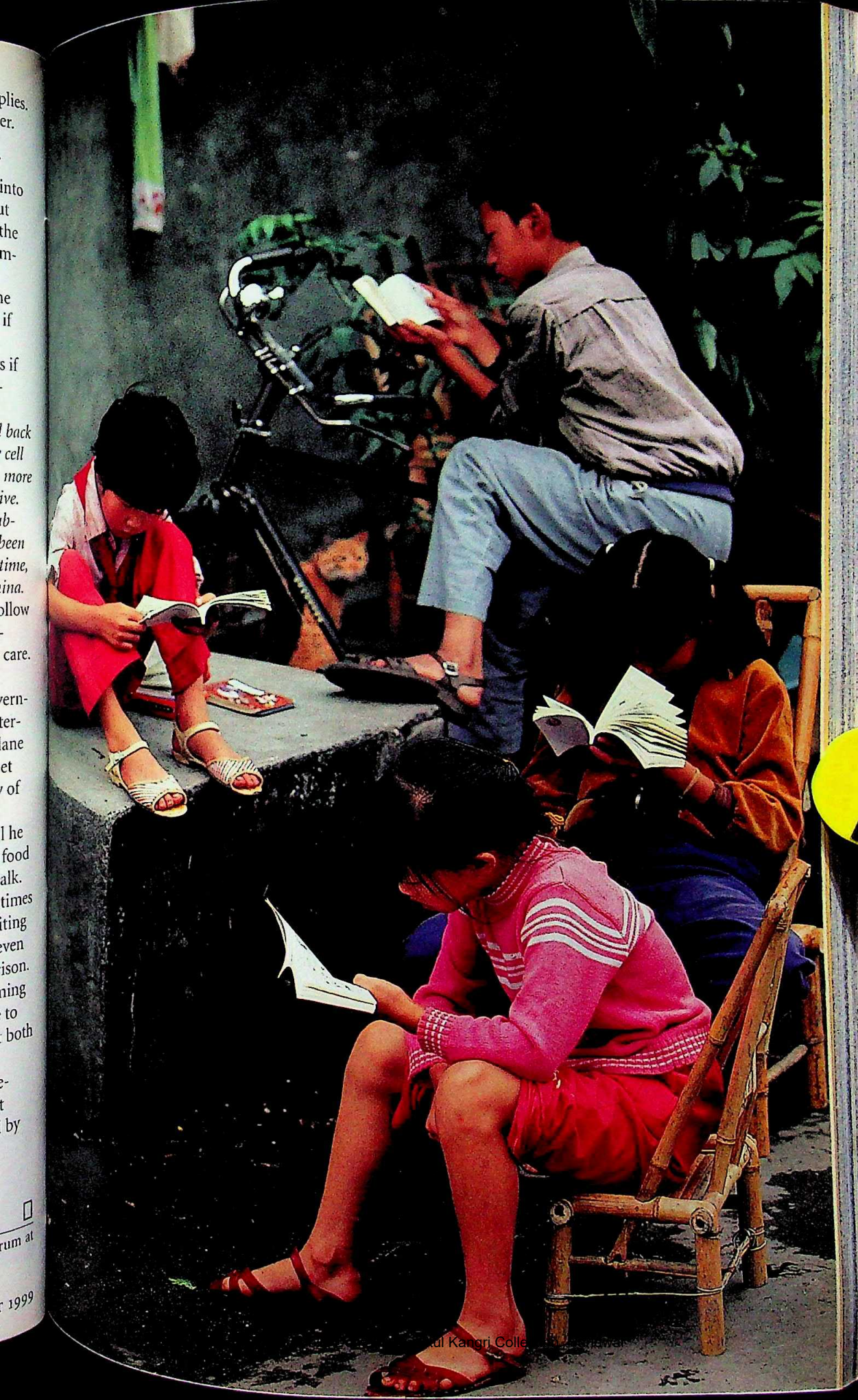

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ACME NEWSPICTURES

■ FROM THE GEOGRAPHIC ARCHIVES

Inflammatory

Words turned to ashes on May 10, 1933, when German students torched "un-German" writings looted from libraries and bookstores across the country. Some 40,000 people gathered on Berlin's Opernplatz that night to hear Nazi propaganda minister Joseph Goebbels speak. "Even if this young generation has been impoverished materially, it has profited spiritually," he told the crowd as it cheered at the flaming of the books, which included works by Einstein, Hemingway, and Helen Keller. "See these flames not only as a symbol of the end of an old epoch, but also as the beginning of a new one."

Goebbels himself knew well the power of the printed word; before the book burning he ordered German news organizations to downplay the event.

This photograph has never before been published in the magazine.

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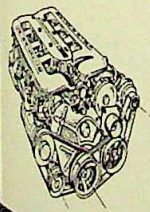
Sometimes you forget the milk.
Sometimes you forget the bread.
Sometimes you forget the store altogether.



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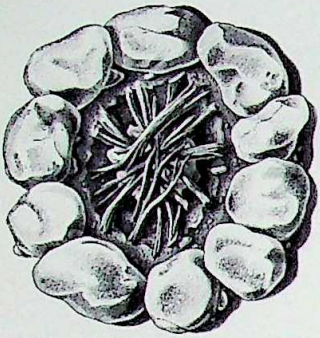
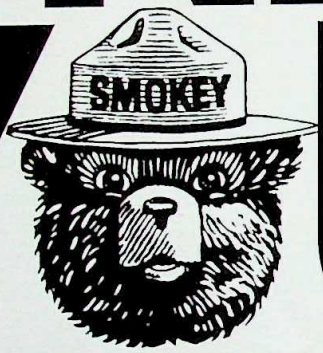


ONLY YOU



Make the Campfire Right Before You Light

Smokey is counting on you to build a safe campfire.

1. Dig a small pit away from overhanging branches.
2. Circle the pit with rocks.
3. Clear a five-foot area around the pit down to the soil.
4. Keep a bucket of water and shovel nearby.
5. Stack extra wood upwind and away from the fire.
6. After lighting, do not discard match until it is cold.
7. Never leave a campfire unattended, even for a minute.

REMEMBER, ONLY YOU CAN PREVENT FOREST FIRES.

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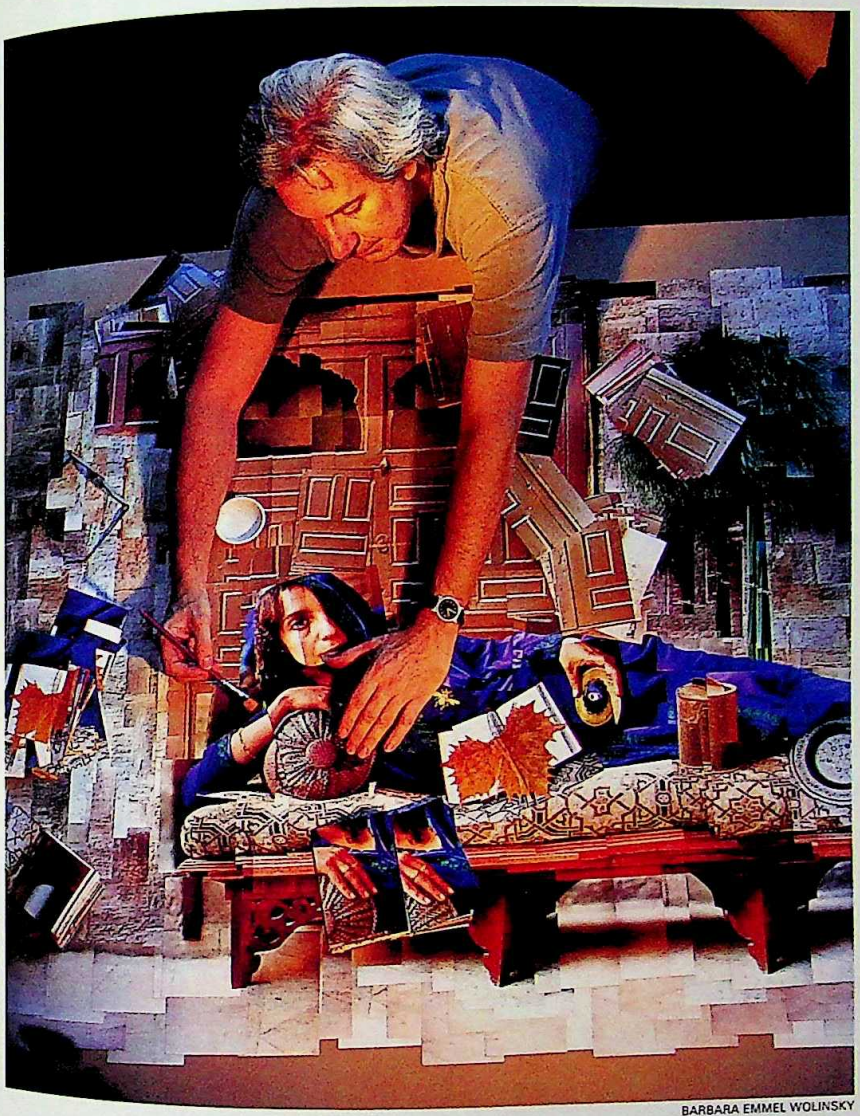

BARBARA EMMEL WOLINSKY

Picturing the Words

While contemplating a statue of Ramses II in a dimly lit corner of the Egyptian Museum of Cairo, all the mind-numbing explanations I had read about Egyptian hieroglyphs suddenly clicked. The sculpture contained visual symbols, some having phonetic values in the Egyptian language. Wondering if it would work in English, I wrote a sentence that could be interpreted entirely in images. My model patiently posed for two eight-hour sessions as I photographed the scene in small sections—an eye, a toe, a few inches of wall at a time. An inexpensive one-hour processor developed the 77 rolls of film. In my hotel room I tiptoed among 2,772 small prints to select the 400 that make up the four-by-six-foot photomontage on pages 111-12.

—CARY WOLINSKY

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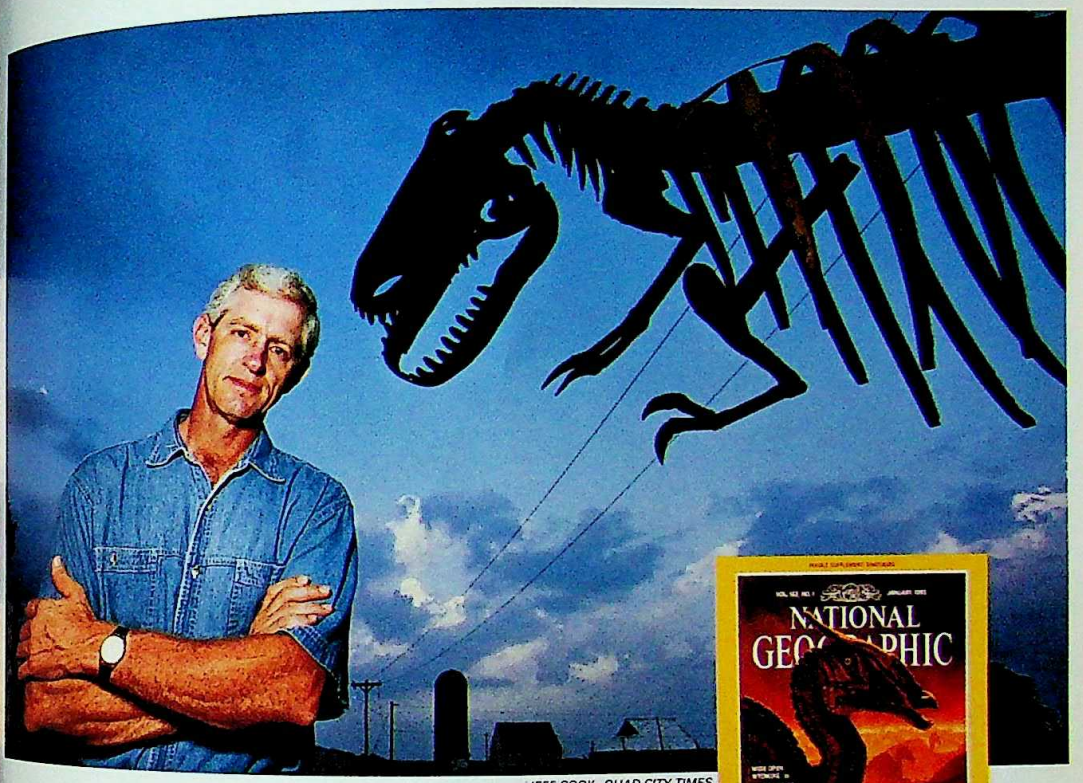
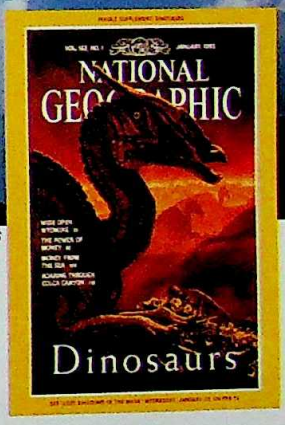


JEFF COOK, *QUAD CITY TIMES*



His Jurassic Spark

Millions of years ago *Tyrannosaurus rex* stalked North America. Now he's back. Farmer—and artist—Chad Randall of Alexis, Illinois, turned to the January 1993 GEOGRAPHIC to help design the life-size scrap-metal dinosaur sculpture he named Rusty Rex. He paged through the magazine to calculate the size of his dinosaur and figure out its anatomy. It took a year of spare-time work to finish.

"I don't consider myself an expert welder," says Chad, who had used his cutting torch only for farm repairs before crafting the creature. "But I've always been interested in making things. I knew I wanted pieces from a hay bale feeder for Rusty's ribs. I used an old cabinet for his head, and I put tractor weights on his feet to keep him steady."

It worked; the dino even survived a tornado last summer that uprooted a few of the Randall family farm's century-old oaks.

Desert Dreams

A limited-edition print of Len Jenshel and Diane Cook's photograph of Utah's Grand Staircase–Escalante National Monument from the July 1999 issue is available for $29.95, plus $6.50 for postage and handling ($9.50 for international orders). Please add appropriate sales tax for orders sent to CA, DC, FL, MD, MI, PA, and Canada. We will produce only as many posters as we receive orders for by September 15, 1999. Each 24-by-30-inch print will be hand-numbered and embossed with the Society seal. Shipping is scheduled for November 1999.

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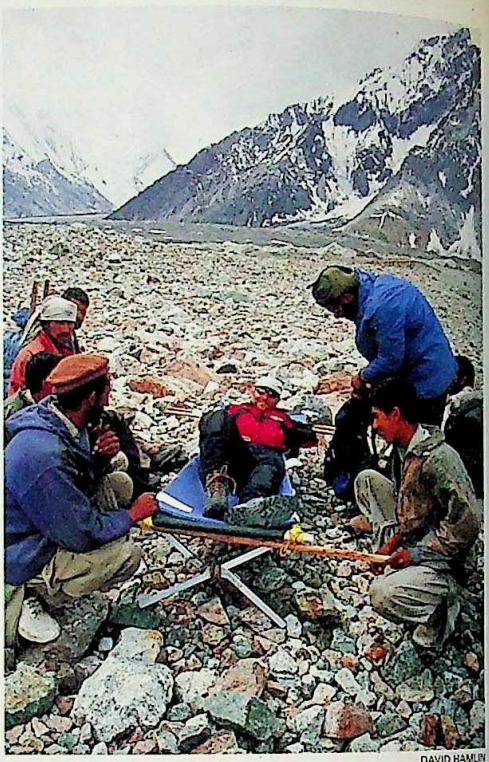
Don't Tell Him to Break a Leg

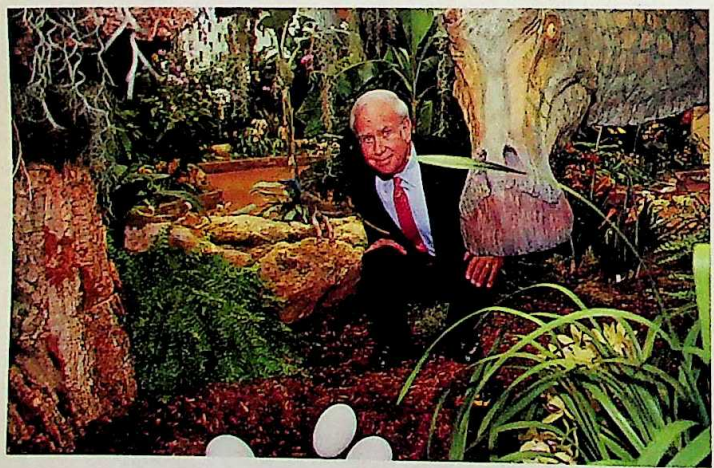
Making the film *Savage Mountains* proved to be a wild time for David Hamlin, the EXPLORER TV producer covering climber Heidi Howkins's K2 summit attempt last August. While he hiked along the slippery shale on Pakistan's Baltoro Glacier, "my leg went one way and my body went another," says David. The tumble ripped the cartilage of his knee, which then locked into a bent position. Packing glacial ice onto his leg to numb the pain and using trekking poles as crutches, David waited while expedition members improvised a stretcher (right) to hoist him above their shoulders for the torturous 12-hour journey to the K2 base camp. Luckily, a Pakistani Army helicopter was in the area to retrieve a stranded hiker, and it touched down to pick up David too. Even in pain, he was still on the job. "I shot great aerials from the rescue helicopter. It was some of my best footage!"

David's injury didn't sideline him for long. He returned to the U.S. to see an orthopedist, had a cast put on his leg, and was back on a plane—to shoot a different EXPLORER show in Iceland—within 20 hours.

This past spring David returned to K2 to follow Heidi Howkins on more daring climbs. He came home with all bones intact.



DAVID HAMLIN



BILL STOVER

Botanical Garden's Raven Flies to Society

Peter H. Raven has been named chairman of the Society's Committee for Research and Exploration. A CRE member since 1982, he will hold the new post while continuing as director of the Missouri Botanical Garden in St. Louis. Environmental issues will be a major focus of Dr. Raven's CRE work. "I'm interested in bringing conservation ideas into the future," he says. Raven was born in China, grew up in northern California, and has always been fascinated by plants and biogeography. He taught at Stanford University before going to Missouri in 1971. Raven is also a member of the President's Committee of Advisors on Science and Technology.

TEXT BY MAGGIE ZACKOWITZ

Geo Olympiad

This month in Toronto a team of finalists from the United States National Geography Bee go up against the best geography students in the world at the International Geography Olympiad. Eleven countries will compete for gold, silver, and bronze medals at the biennial competition.

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SEPTEMBER 1999

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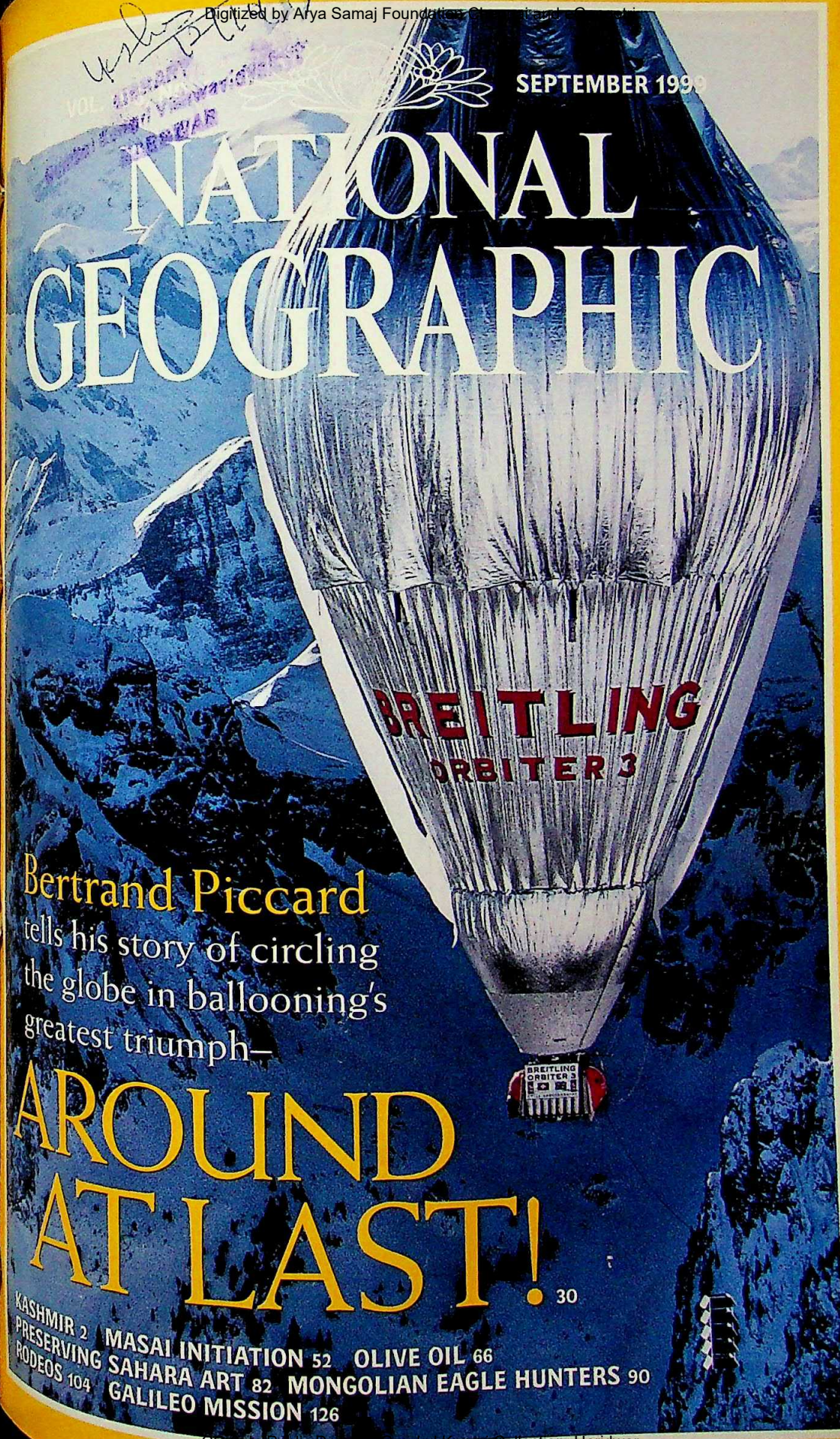

Bertrand Piccard tells his story of circling the globe in ballooning's greatest triumph–

AROUND AT LAST! 30

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Lotsee, Oklahoma. Holds nine.

(The name comes from

the Indian word that means

"Bright Child.")

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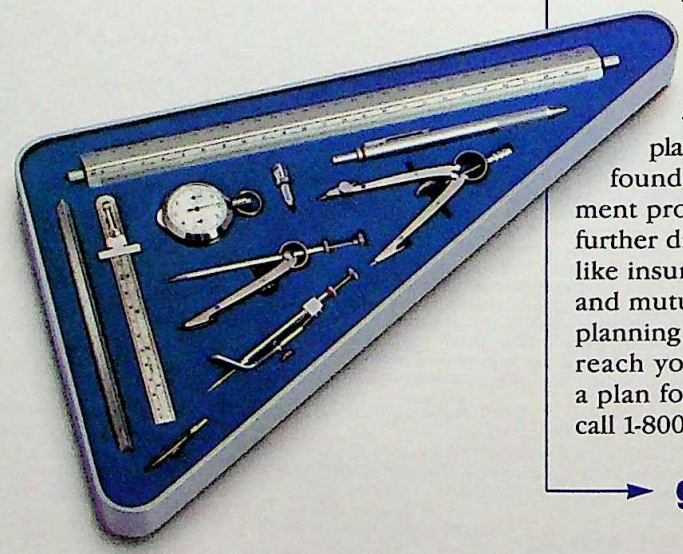

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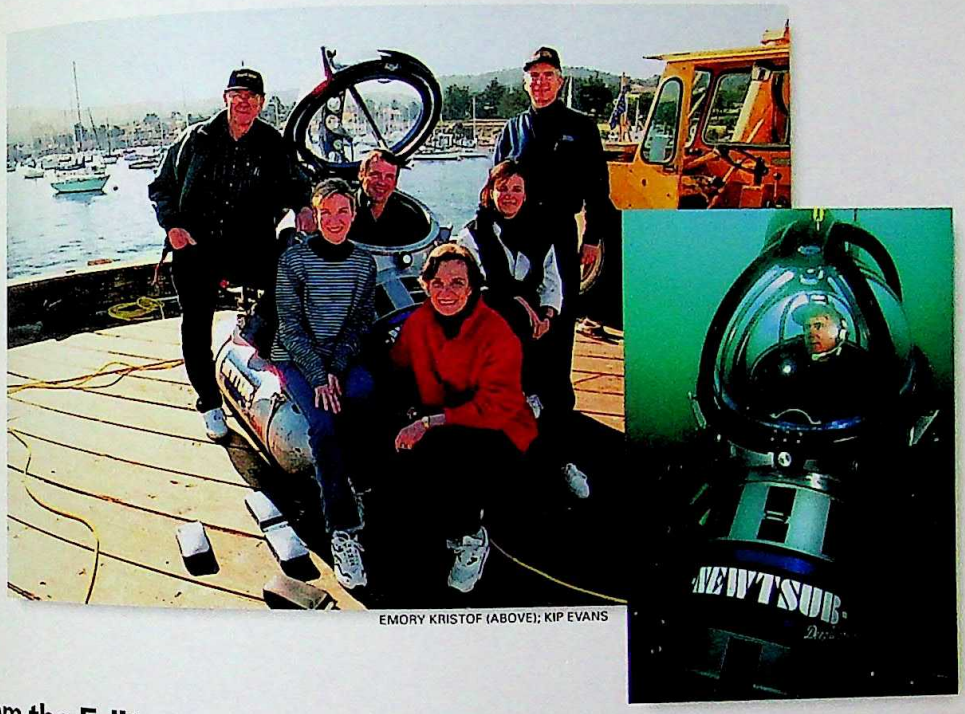

EMORY KRISTOF (ABOVE); KIP EVANS

From the Editor

LAST WINTER I JUMPED AT THE CHANCE to pilot *DeepWorker* (above right), a single-passenger submarine the Society is using as part of its five-year, multimillion-dollar Sustainable Seas Expeditions research initiative. Peering through the submersible's clear dome 40 feet down in California's Monterey Bay, I watched sea lions swimming playfully around me and felt completely at ease in the idyllic undersea environment.

Taking turns with me on these shakedown cruises were, clockwise from top left, Gil Grosvenor, the National Geographic Society's Chairman of the Board; John Francis of the Committee for Research and Exploration; Margaret Sears, the Society's director of development; Sylvia Earle, our host and explorer-in-residence; and Susan Reeve of our Expeditions Council.

During his dive Gil made a less than idyllic observation: "I could follow the trail of beer cans all the way out to the bay." That speaks to the importance of finding ways to preserve and protect our marine sanctuaries. The Society-wide crew on that Monterey dock illustrates National Geographic's commitment to making Sustainable Seas a success.

Bill Allen

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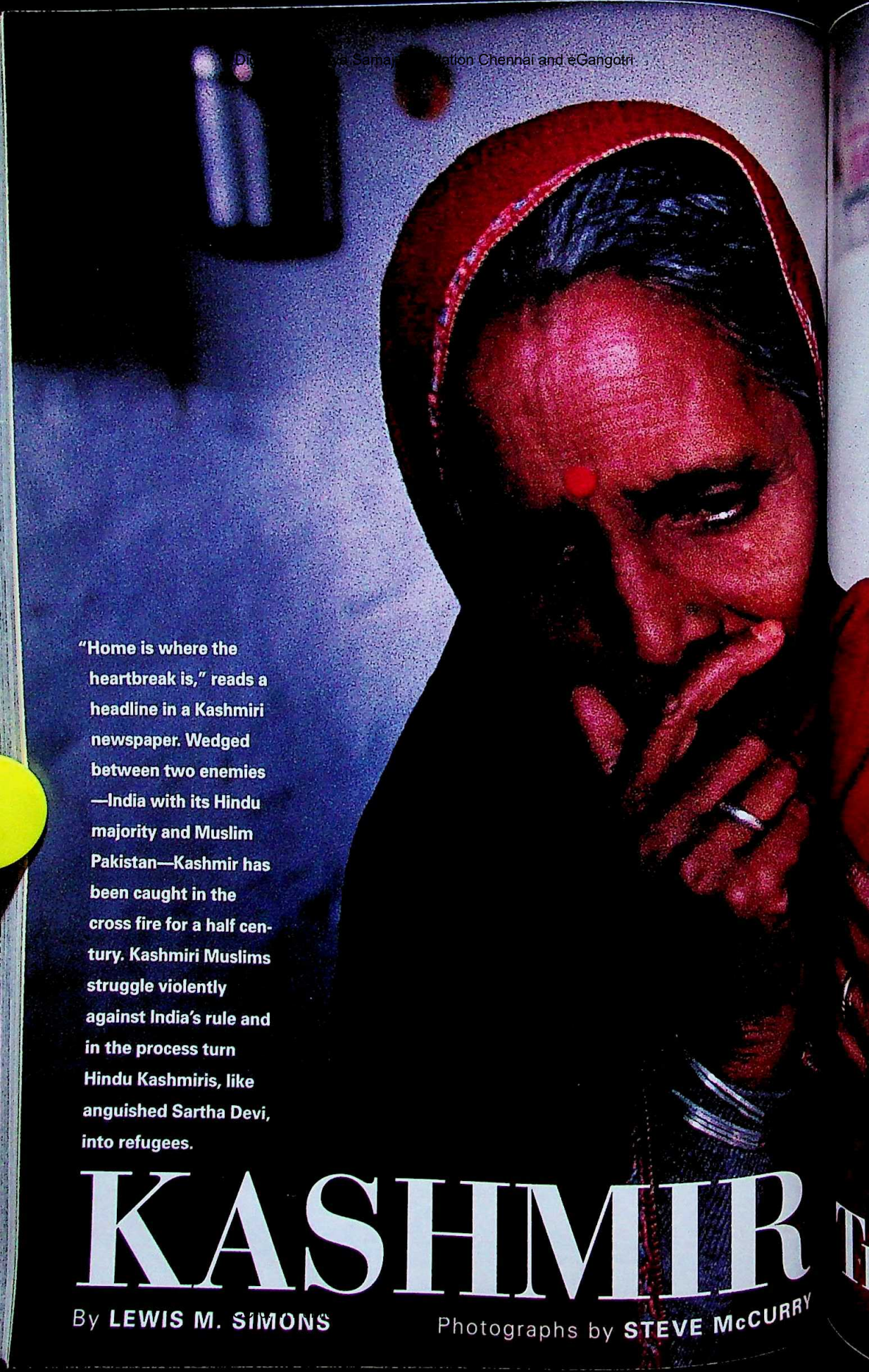

"Home is where the heartbreak is," reads a headline in a Kashmiri newspaper. Wedged between two enemies —India with its Hindu majority and Muslim Pakistan—Kashmir has been caught in the cross fire for a half century. Kashmiri Muslims struggle violently against India's rule and in the process turn Hindu Kashmiris, like anguished Sartha Devi, into refugees.

KASHMIR

By **LEWIS M. SIMONS**

Photographs by **STEVE McCURRY**

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Trapped in Conflict

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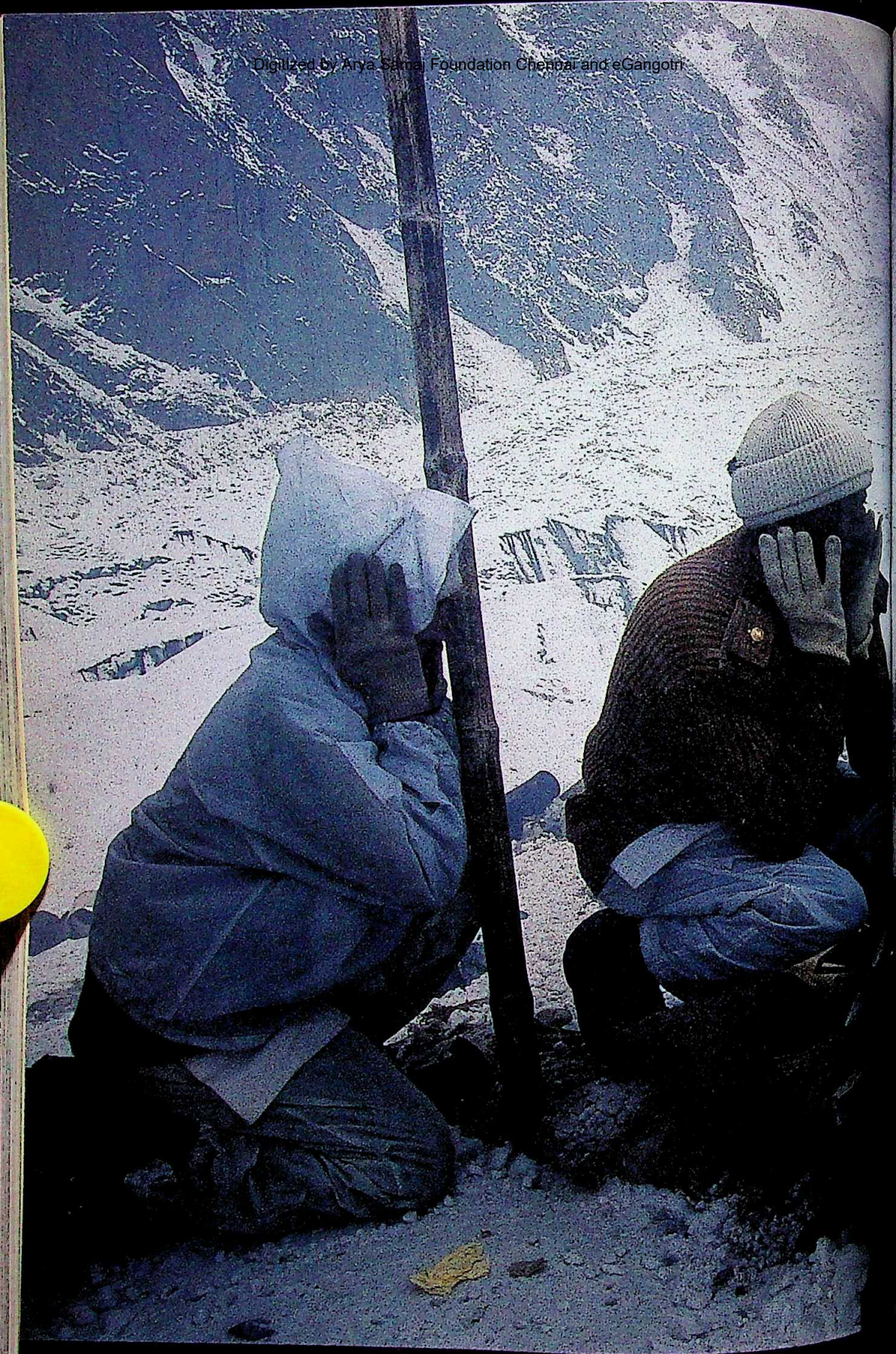

Artillery thunder shakes the Karakoram Range as Pakistani soldiers trade fire with Indian opponents across the Siachen Glacier. The deadly game of serve

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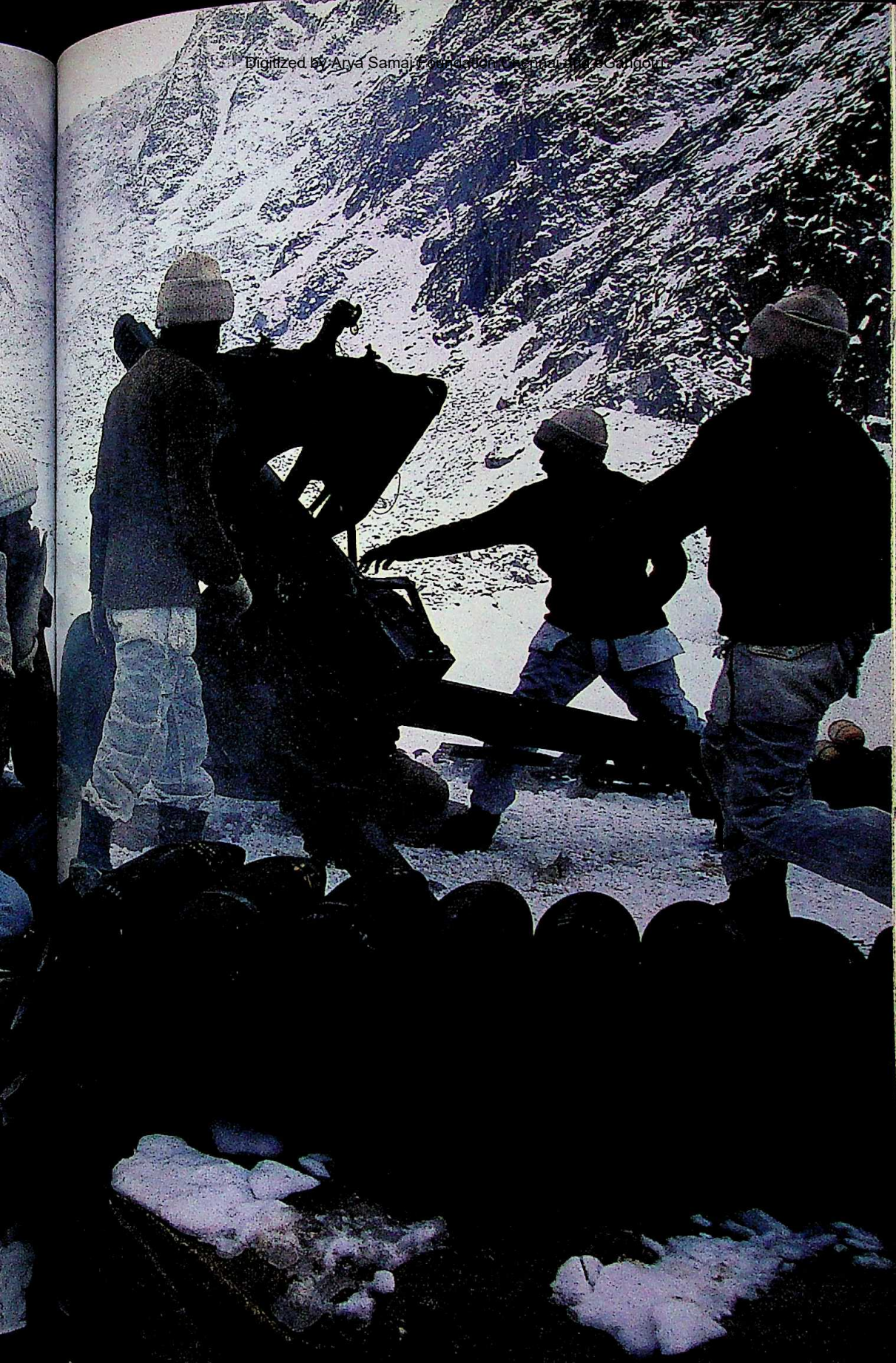

and volley has erupted into all-out war three times since British colonial rule ended in 1947. Risks are growing: Both nations have tested nuclear weapons.

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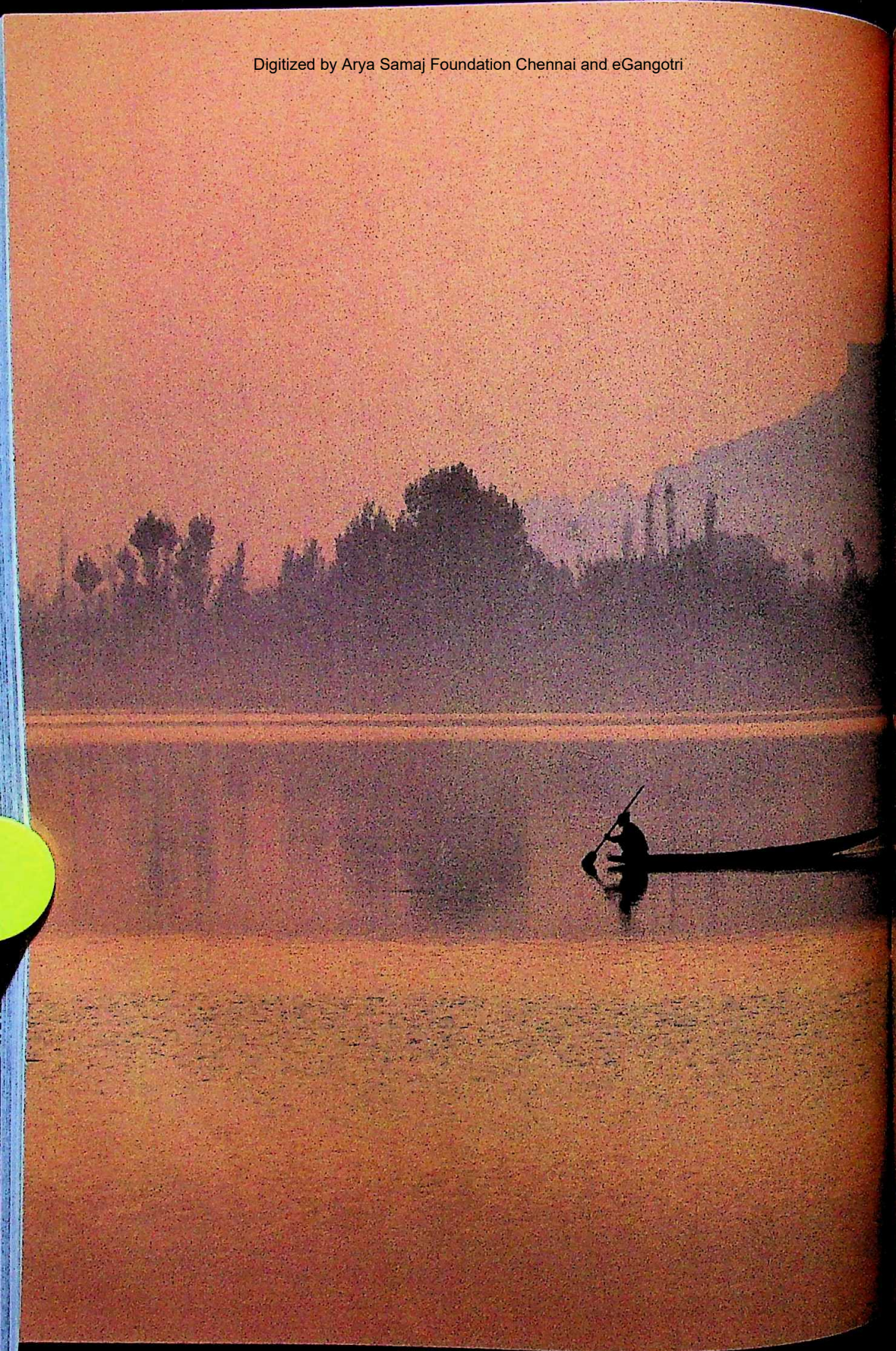

A 16th-century fortress looms over the dawn-burnished waters of Dal Lake in the Vale of Kashmir. India controls this densely populated, predominantly

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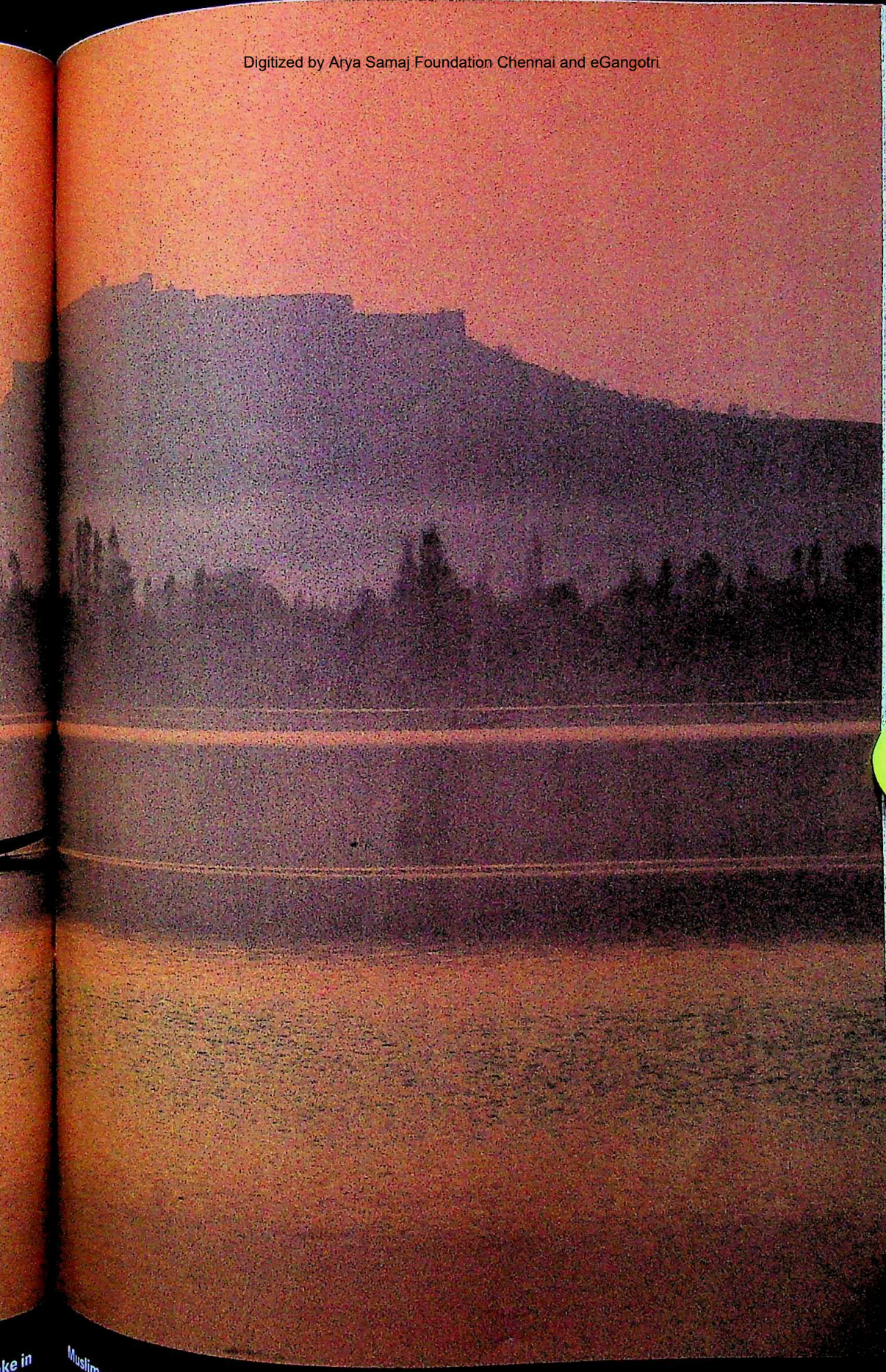

Muslim area. Pakistan depends on rivers flowing out of Kashmir—the Jhelum, the Chenab, and the Indus—to irrigate fields and generate electricity.

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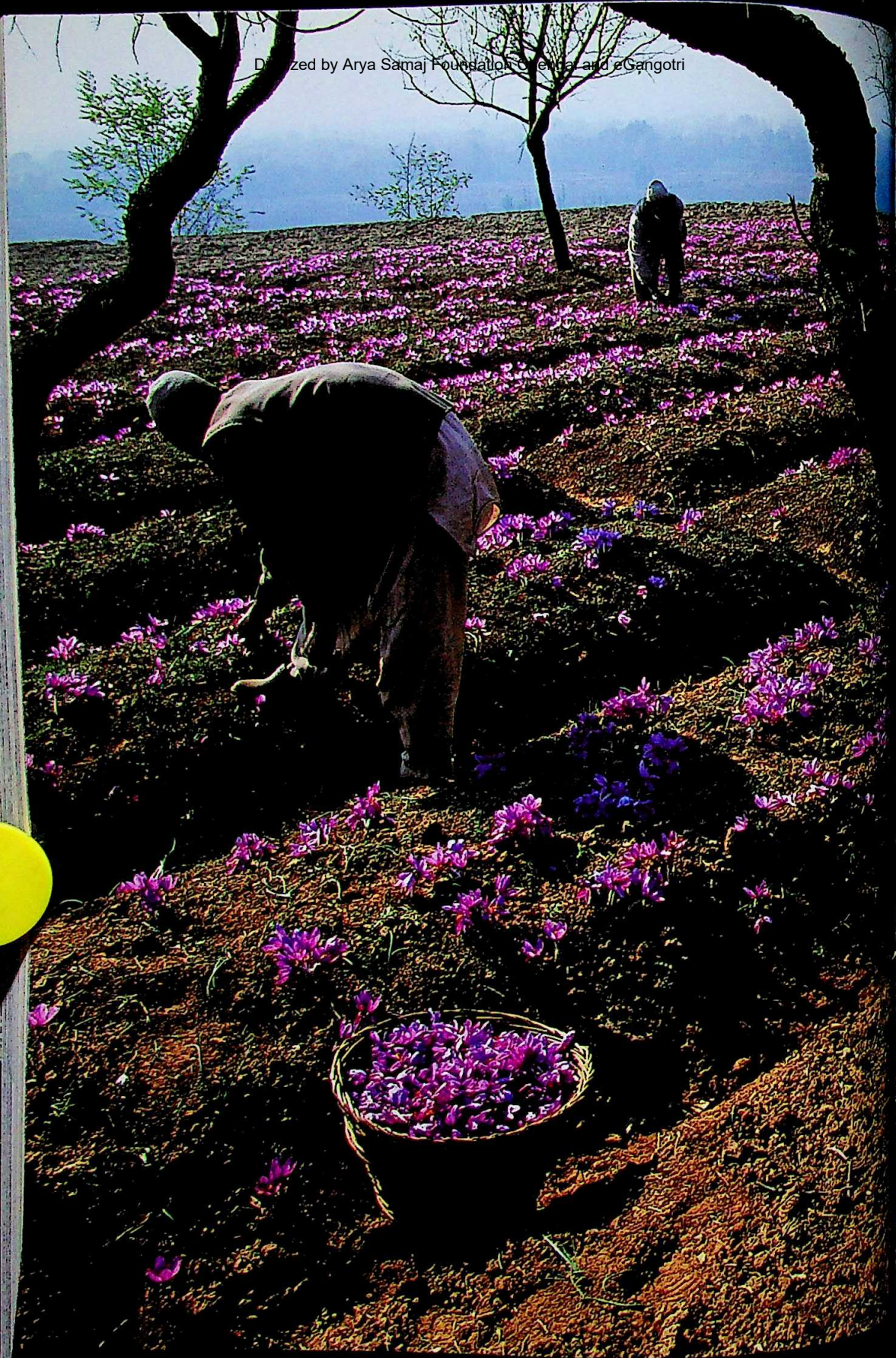

From each crocus flower patient hands will pluck three vivid garnet strands of saffron. An acre yields only a few pounds of the world's most costly spice.

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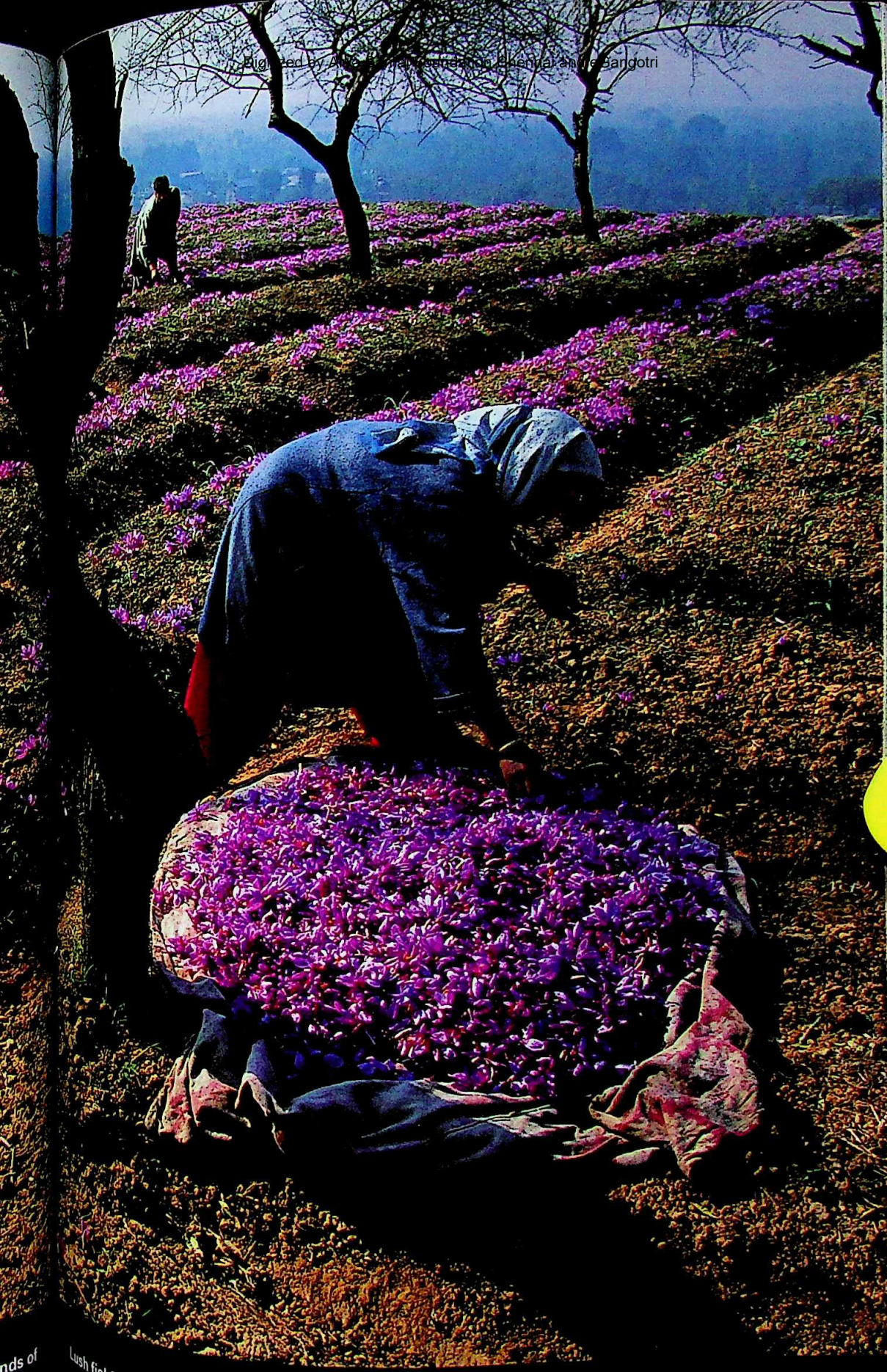
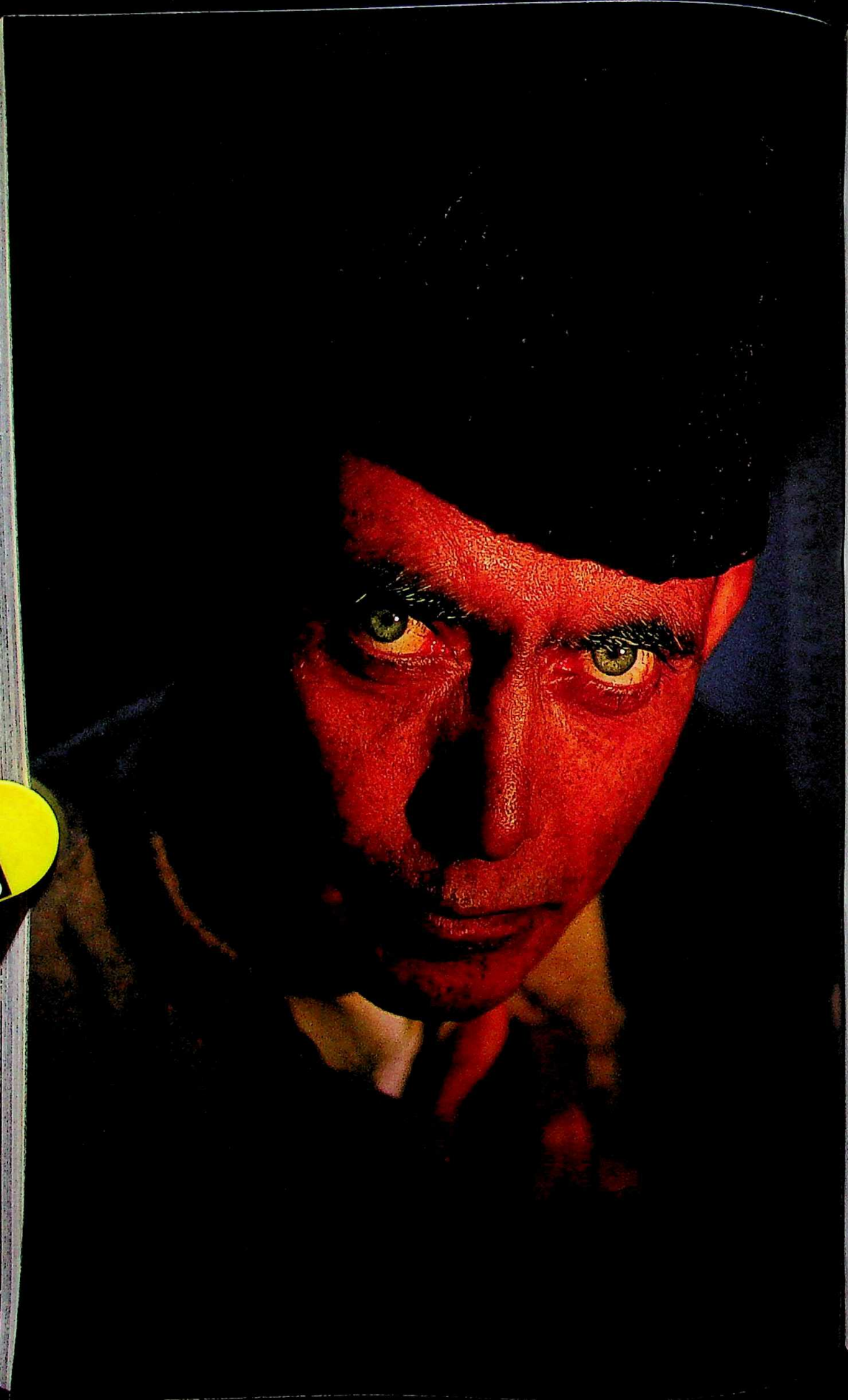


Lush fields and placid lakes once drew more than half a million visitors a year, but civil unrest has shattered Kashmir's calm and left tourism in shambles.



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Dodging bomb blasts and gun battles, engineer Maqbool Andrabi kept public water flowing for years in Srinagar, Kashmir's summer capital. "Nights were sleepless," he recalls, "and days full of fear."

Kashmir calls back, its pull stronger than ever, it whispers its fairy magic to the ears, and its memory disturbs the mind.
—Jawaharlal Nehru, first prime minister of India, 1940.

Where World Ends and Paradise Begins
—roadside sign in 1998 on the Indian side of the cease-fire line separating Indian-held Kashmir from Pakistani-held Kashmir.

KASHMIR IS NO LONGER a magical place. On a day like many others, against a backdrop of green mountains sliced through by the glittering Jhelum River in Azad Kashmir, a ragged little cavalcade comes into focus. Men and women and their children trundle down narrow, rocky trails, staring into the middle distance, idly poking a stick at a cow here, a goat there, sandaled feet stirring puffs of red dust. Some carry small bundles wrapped in blankets; some have bloody bandages tied around heads, arms, and legs.

Muzaffar Shah, a bulky man in his mid-30s, says he doesn't know or care where he's going, just that he get far away from where he'd set out the day before. That place was his village, Tafarabad, near the Pakistani Army outpost at Chakothi. For three days Indian Army artillery had been shelling Tafarabad across the cease-fire line, or line of control (LOC), as it has been known since 1972, which divides the disputed territory of Kashmir. Muzaffar Shah doesn't know how many of his relatives and neighbors have been killed or injured by the Indians, but he guesses about seven.

Along an unpaved road nearby, Pakistani Army trucks, buses, taxis, and pony carts jouncing in a haphazard convoy spill over with refugees fleeing other villages near the LOC. Mothers in loose, flowing robes and shoulder-length head scarves somehow retain an innate grace as they cradle eerily quiet babies. Bearded men in baggy tunics and pants clutch string beds, rolled carpets, and cooking pots.

Just a few days before, I'd been on the Indian side, above the dust-blown town of Uri at the spit-and-polish command post of the Indian Army's 12th Infantry Brigade, and had seen the mirror image of what was happening now: shells from the Pakistani side screaming in, killing and maiming villagers.

"Firing across the LOC is so ordinary that you can't digest your breakfast until you've fired off a few rounds," an Indian *jawan,* or trooper, to whom I'd given a lift, had told me with a cocky grin.

Indeed the cease-fire line, which was drawn up by the United Nations in 1949 and snakes erratically for about 500 miles through some of the roughest terrain on Earth, has been breached far more often than honored. India and Pakistan each maintain several dozen military outposts along the line of control. Almost daily, duels such as the one I was witnessing are waged between heavy weapons set no more than eight or nine miles apart from muzzle to muzzle. Since it's illegal to cross the line, a journalist must travel hundreds of miles by road and air to get from one army to the other.

On both sides I heard the same protestations about the bloodshed. Officers would tell me, straight-faced, that the enemy was zeroing in on helpless victims while *they* were firing only at military targets. I never did learn who fired first on that occasion, but a day after I'd arrived in Uri, according to newspaper accounts, 16 people had been killed nearby on the Indian side. They had been taken from their houses and shot, reportedly by Muslim guerrillas. It was the third such act in just over a month. All the victims were Hindus.

The neighborhood fight over Kashmir has been going on since 1947, when the British partitioned predominantly Hindu India to create Pakistan as a homeland for South Asia's Muslims. Jammu and Kashmir—a princely

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LEWIS M. SIMONS, a Pulitzer Prize-winning journalist, first reported on Kashmir in 1972 as the New Delhi correspondent for the *Washington Post.* STEVE MCCURRY has won numerous awards for his photographs of people caught up in conflicts as far afield as Sri Lanka and Yugoslavia.

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state with a primarily Muslim population ruled by a Hindu maharaja, Hari Singh—floundered. The maharaja wanted independence for the state, but he didn't know how to get it. At the 11th hour he signed an agreement of accession to India, but by that time Pakistani-backed tribal fighters had invaded Kashmir.

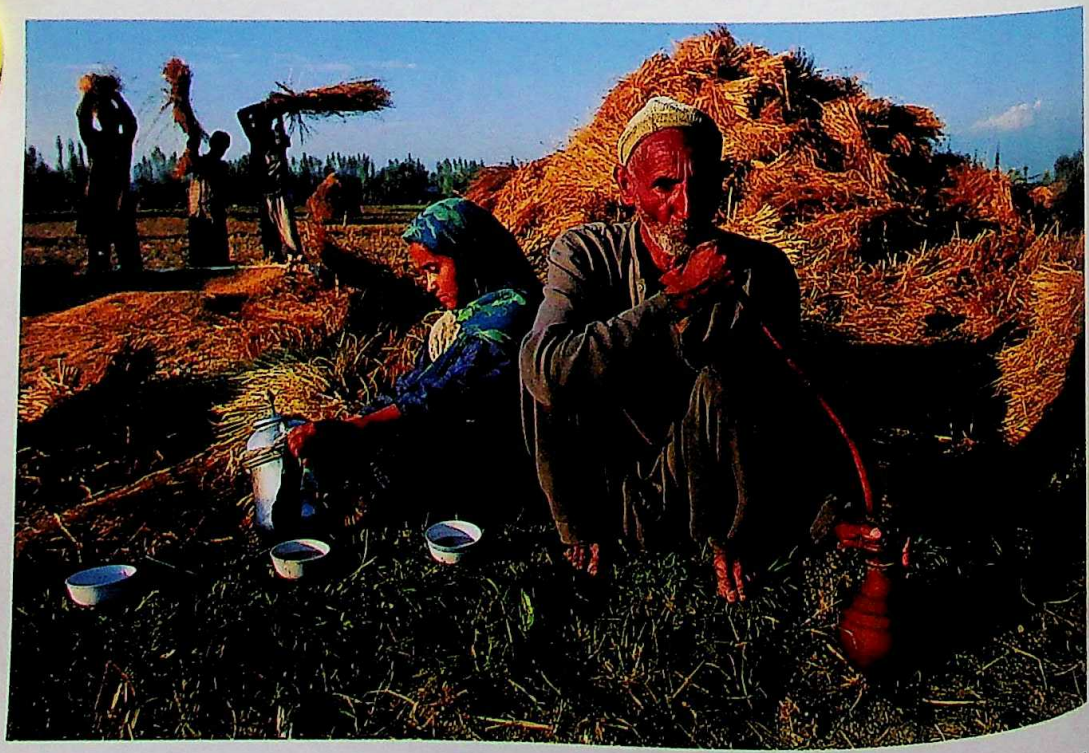
The leaders of India and Pakistan were desperate to acquire Kashmir to bolster their respective visions of nationhood. India's Jawaharlal Nehru, the secularist, wanted to demonstrate that an Islamic population could coexist with the Hindu majority; Mohammed Ali Jinnah, the Muslim nationalist, insisted that Pakistan would be incomplete without the Muslim enclave. Almost immediately the two countries went to war, tearing Kashmir apart. Ebbing and flowing, that war has, in essence, never ended. Today there are some 400,000 Indian troops in Kashmir and about half as many Pakistani soldiers.

Beneath the surface of this South Asian geopolitical game board are the aspirations of a people who consider themselves Kashmiris—neither Indian nor Pakistani—but who live divided by an artificial line. Hardly a day goes by without local newspapers in both countries reporting new violence—from artillery shelling across the LOC, from cross-border incursions of Muslim guerrillas backed by Pakistan, from indigenous Kashmiri Muslim militants who have been fighting Indian security forces for independence since 1989. These confrontations have blended together in a single cauldron of blood.

Casualty figures from fighting in and over Kashmir since 1947 are notoriously unreliable. In the past ten years—the period of the Kashmiri Muslim militancy—an estimated 30,000 to 40,000 Kashmiri civilians and militants and Indian and Pakistani soldiers have died. Indian police place the toll at 24,000; Kashmiri Muslims say it's more like 80,000. Both India and Pakistan now have nuclear weapons, and because Kashmir is the flint against which either could strike a nuclear spark, fatalities of this magnitude could become mere footnotes.

Why these two countries would remain at each other's throat for so long, at such cost in life and fortune, over a remote patch of land comes down to the great truism of real estate:

Grandfather supervises the October rice harvest, drawing slowly on a water pipe, while a teenager prepares tea for their weary kin near Srinagar. Family farms and orchards support some 80 percent of Kashmir's population.



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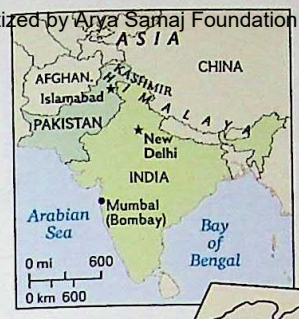
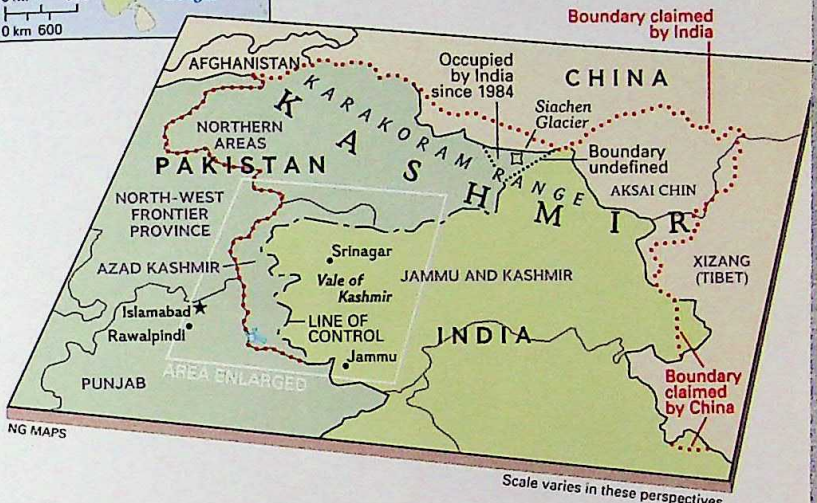
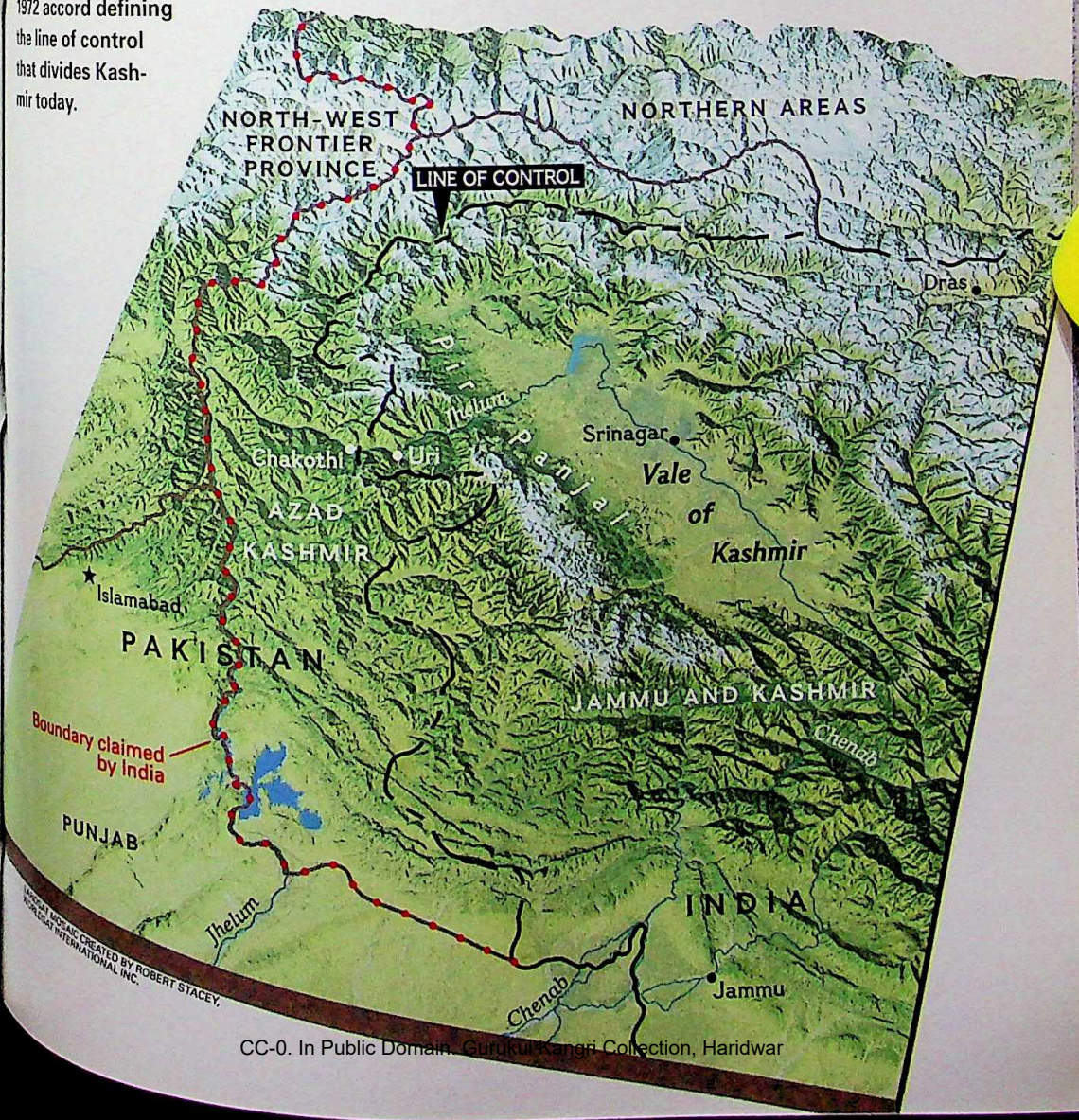
KASHMIR
Himalayan Battleground

Politics tangle boundaries. Territory claimed by India was part of the princely state of Jammu and Kashmir before 1947. After a war in which Pakistan held the Northern Areas and Azad Kashmir, U.N. peacekeepers drew a cease-fire line between the rivals in 1949. China won Aksai Chin in a 1962 war with India, carving off another piece of the state of Jammu and Kashmir but magnifying India's resolve to hold adjacent territory, where a Buddhist majority has strong ties to Tibet. India again fought Pakistan over Kashmir in 1965; a third Indo-Pakistani war led to a 1972 accord defining the line of control that divides Kashmir today.





Scale varies in these perspectives.



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Scores of *shikaras* laden with fruits and vegetables jostle for space on Dal Lake as farmers transact the early morning business of Srinagar's wholesale

produce
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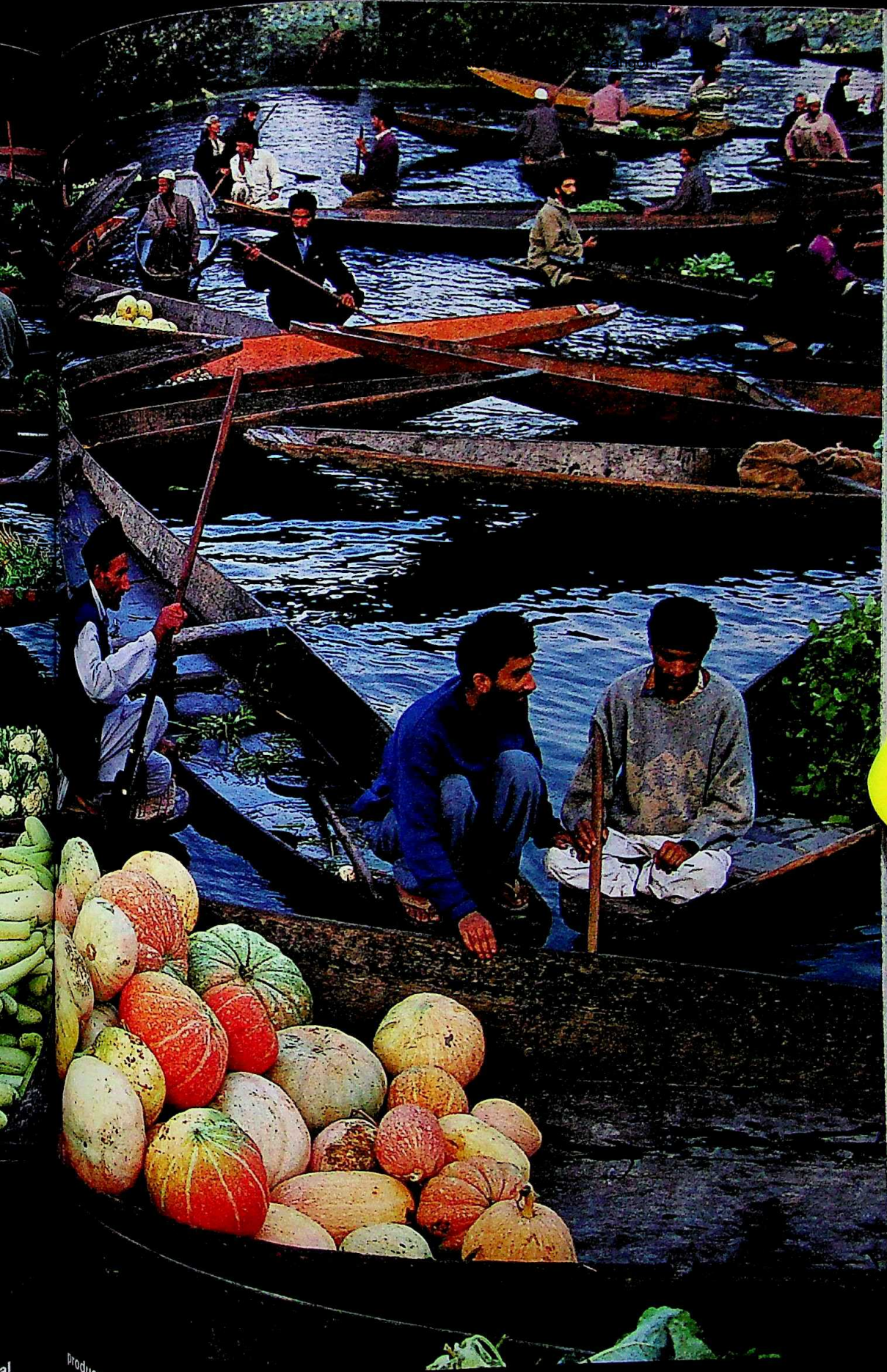

produce market. Some farmers tend floating gardens: They weave stalks of water plants into a living offshore raft, cover it with soil, and put in crops.

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location. Kashmir perches like a raja's jeweled turban in the Himalaya at the very top of the great subcontinental landmass. There it is a gateway—or a barrier—between the two protagonists as well as between them and China and Afghanistan. Kashmir also sits astride Pakistan's major rivers: the Indus, the Jhelum, and the Chenab.

THIS LAND EXERTS a powerful emotional pull as well. Millions of sweltering, plains-dwelling Indians and Pakistanis dream of its green mountains, its blue rivers and lakes, its fertile farmlands and cool, dry climate. Kashmir is their Maui, Aspen, and Palm Springs all rolled into one. Hindi-language musicals from Mumbai's (Bombay's) "Bollywood" movie studios still court success at the box office with scenes of lovers romping through flower-strewn Kashmiri meadows and snowy hillsides.

When Kashmiris speak of Kashmir, more often than not they're thinking of "the valley," the Vale of Kashmir, which lies wholly under Indian control. Only a fraction of what India rules as Jammu and Kashmir state, the valley is ringed by the high peaks of the Himalaya and the ridges of the Pir Panjal. It is a lush green heartland of thick pine and fir forests, with fields of rare saffron crocuses and terraces of rice bordering mulberry groves and orchards heavy with apples, pears, plums, and walnuts. Centered on the city of Srinagar, the valley is the prize.

In the 1970s when I was a foreign correspondent based in India, I would take my family up to Kashmir in summer to escape the New Delhi furnace. On Dal Lake in Srinagar, then, as now, Kashmir's summer capital, we'd rent a houseboat of polished wood, carved with the fanciful patterns of an Oriental carpet. Like latter-day colonials, my wife and I would sip gin-and-tonic sundowners on the rear deck while our two little girls paddled around in a dainty *shikara*, a kind of gondola, with a boatman who'd be delivering groceries.

We'd stroll through twisting medieval streets, among half-timber and plaster structures, more like old Europe than old India. We'd be accosted by honey-tongued souvenir wallahs, offering sets of walnut stacking tables, papier-mâché boxes, magnificent hand-knotted wool and silk rugs, and feathery shawls of wool harvested from the Kashmir goat. Kashmir was, if not quite paradise, certainly a delight.

Atop an armored truck, a flak-jacketed member of India's Border Security Force stands watch over Srinagar's busiest intersection. Since separatist fury exploded in 1989, New Delhi has committed as many as 400,000 army and paramilitary troops to the region. "In the valley," says Kashmiri journalist Surinder Oberoi, "violence poisons everyday life." Death toll estimates for the decade range from 24,000 to 80,000.

All that is no more. In the summer of 1995 Muslim insurgents from the Indian side seized six Westerners. One, an American, managed to escape. A Norwegian was later found beheaded, and the remaining four are assumed dead. The next summer another local Muslim group killed six Indian tourists on Dal Lake.

Returning to Srinagar for the first time in more than 20 years, one of my first stops was Butts Clermont Houseboats, at Nasim Bagh, on the shore of Dal Lake. The lake hadn't been very clean even back then, but now it gave off the smell of raw sewage. Illegal squatters have moved onto the marshy shore, where they tend vegetable gardens and sell their huge rosy turnips, green squashes, and fat cabbages from

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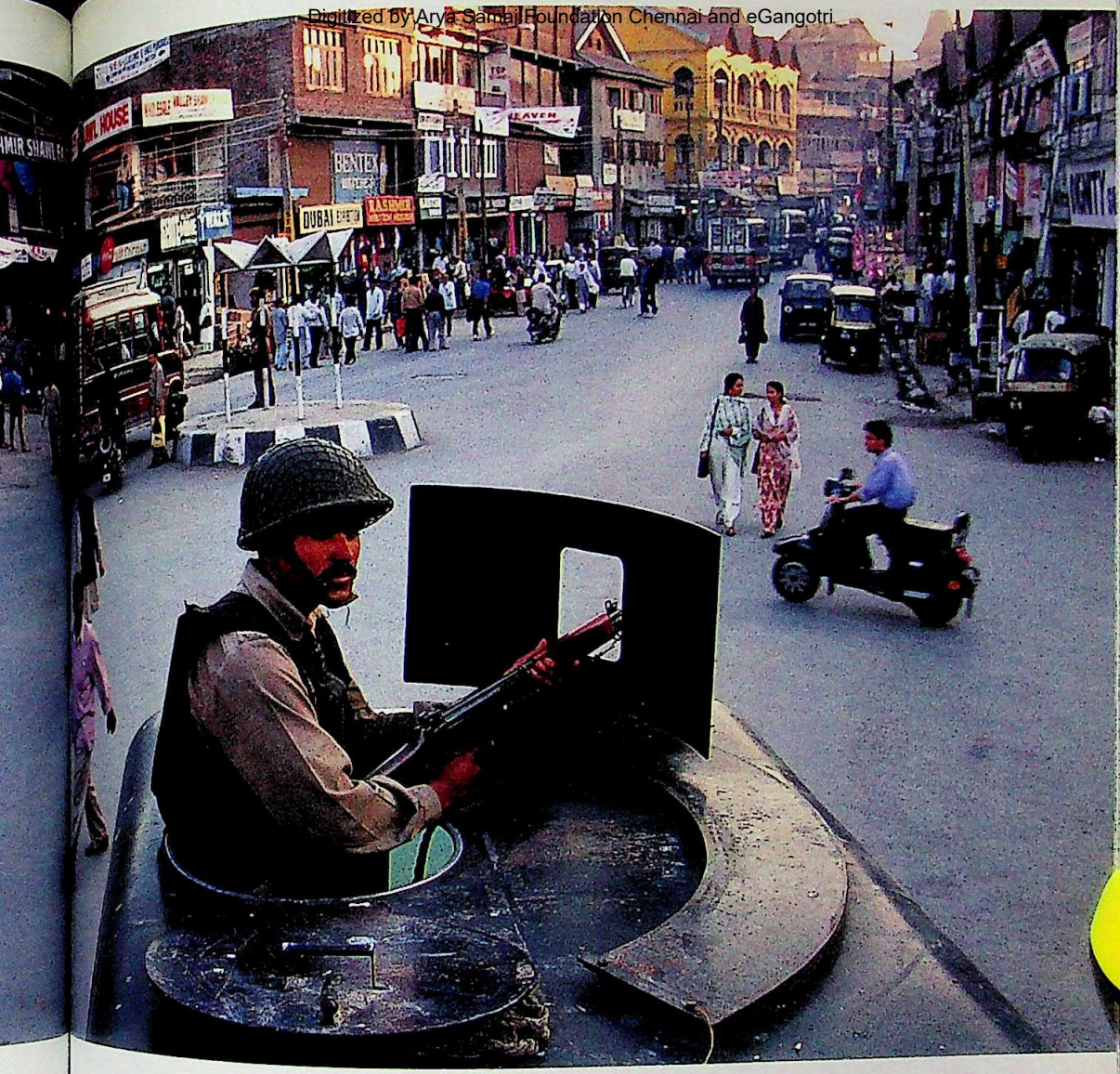

wooden boats at a floating market held early each morning. Everywhere, the state government had posted green-and-white signs reading, "Save Dal Lake."

Old Mr. Butt, whom I remember as the most genial of hosts, with his flowing white beard and crocheted white skullcap, died some years ago, and his son, Gulam Butt, greeted me with a warm "*salaam aleikum*—peace be with you" and a formal embrace. He led me from his tree-shaded office, hung with fading photographs of past guests, such as Nelson Rockefeller, Joan Fontaine, and George Harrison, through a well-tended rose garden onto an immaculate houseboat. In a moment tea and biscuits materialized.

We talked about old times and old friends, and then I asked him how business was. His face fell, and he sent for a stack of guest books. More than half a million tourists, Indian and foreign, visited Kashmir annually during the 1980s, and the signatures of guests who stayed with the Butts during that time filled four fat ledgers. But in the past decade, as the Muslim insurrection intensified, all the signatures combined covered less than a single page, and nearly all of those were journalists. Gulam Butt shut down four of his eight boats.

I was surprised he'd had any bookings at all. From where we sat, I could see Indian soldiers patrolling the streets in pairs, wearing body armor over camouflage fatigues and hefting automatic rifles chained for security to their web belts. Major intersections were dominated by sandbagged bunkers, their entrances draped in stout netting to keep grenades out. Armed militiamen halted cars and sputtering trishaw taxis, shoving the drivers around and

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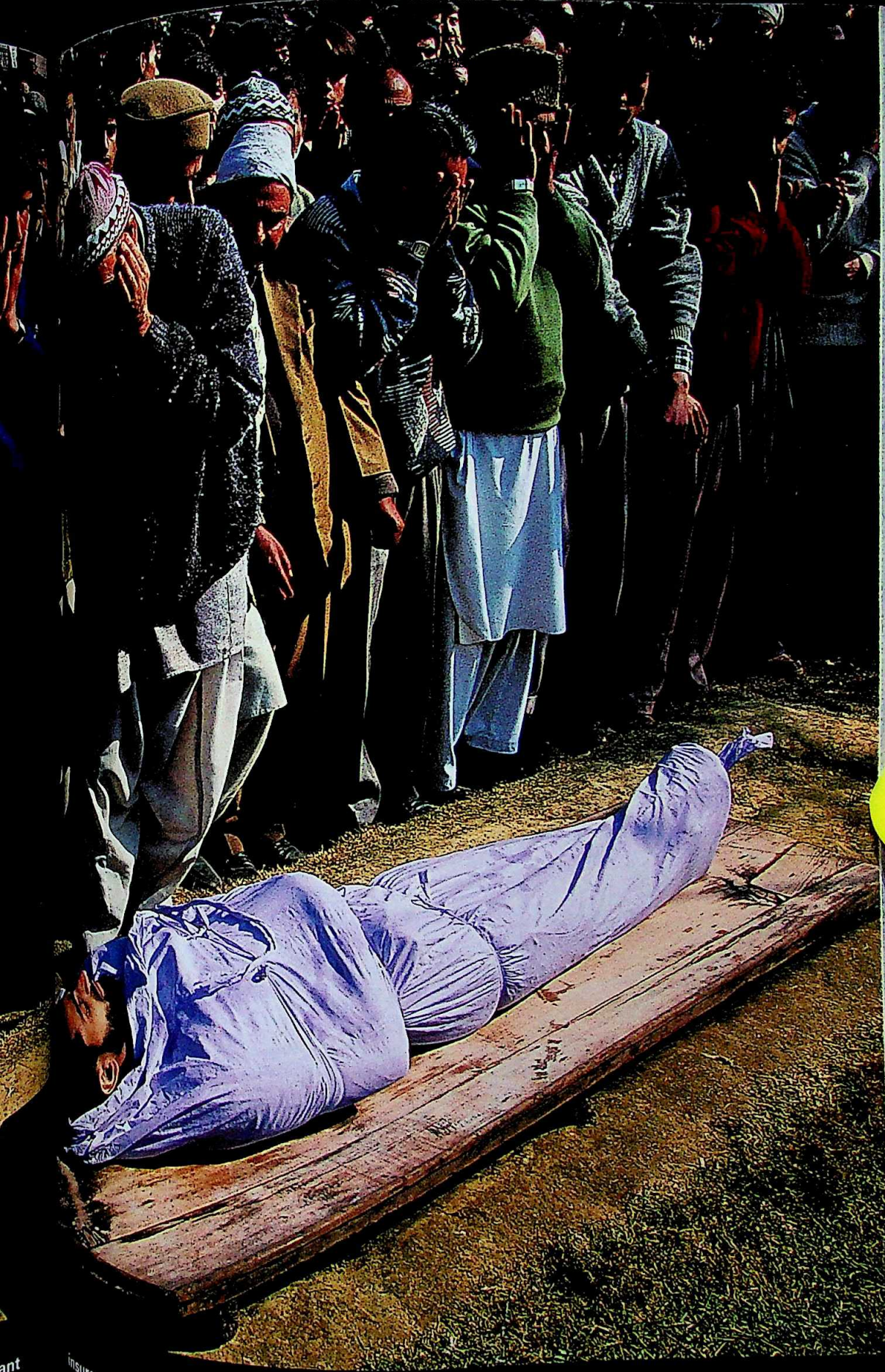
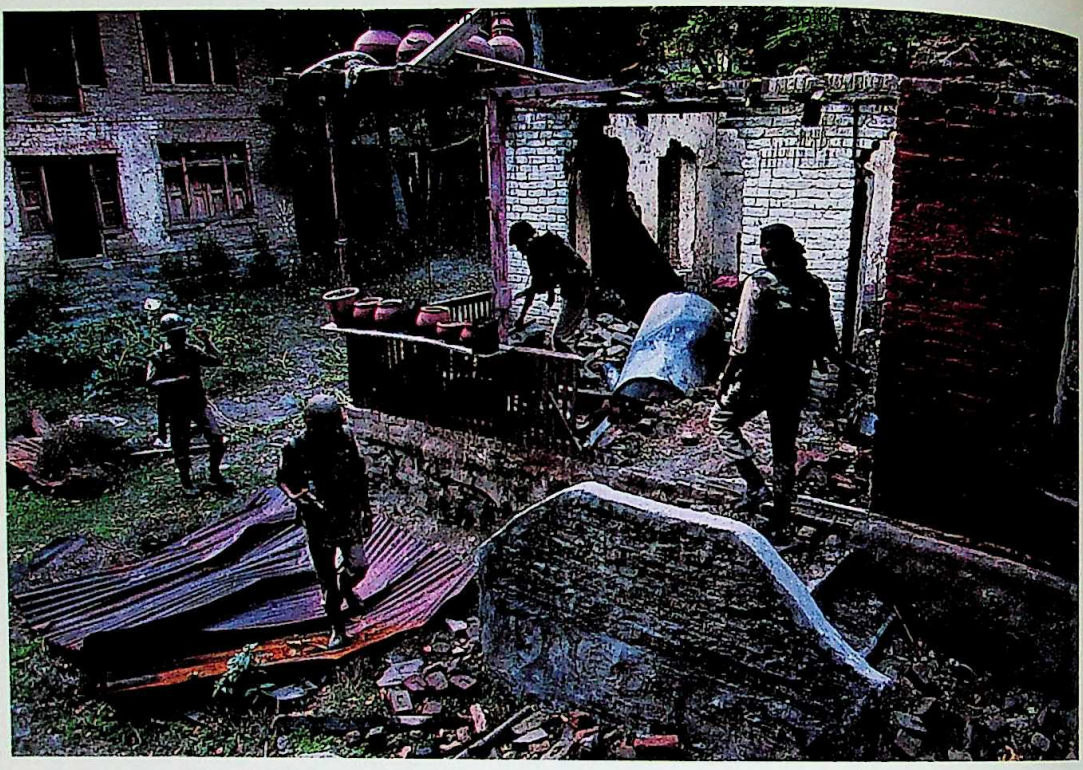
Slumped in grief, a Muslim cleric leads funeral prayers for his son—militant leader Shariq Bakshi—killed by Indian security troops. Some call Kashmir's



insurgents *mujahidin*, holy warriors for Islam. Others call them criminals, whose victims—of kidnapping, extortion, and rape—are often other Kashmiris.



Their houses and temple torched, 23 Hindu men, women, and children were killed in January 1998 in Wandhama, where security forces patrol the ruins (above). Survivors fled, joining more than 150,000 other Hindus driven from their homes by ethnic hatred since 1989. Some resettled in other parts of India, but many remain in squalid refugee camps like the one at Nagrota (right), outside Jammu.

rooting beneath seats in search of bombs. Burning glances from passersby made plain that Kashmiris regard the soldiers as a foreign army of occupation—much like the British Army in Northern Ireland—not a gendarmerie there to protect them.

Despite so much ugliness, most of Kashmir's legendary beauty remains unscarred. Even in the heart of Srinagar, where concrete box-style buildings are spreading like inkblots, enough of the old remains intact to whisk the visitor's imagination back to what the city must have been in its glory. Said to have been founded by the Buddhist Emperor Ashoka during the third century B.C., Srinagar focuses on water—Dal Lake, the Jhelum River, and a looping canal that joins the two, effectively making an island of the city's busiest section. Some two dozen bridges, many of them stone relics, arch over the river and the canal, vantage points for glimpses of boatmen poling small wooden vessels past antique houses.

The city's water reaches it from sources high in the mountains, and because of the purity of the swift Himalayan streams, travelers in the highlands love to pause where road and stream meet. I often did so myself—to drink and wash, to gaze up into the hills at little log houses with sun-sparkled metal roofs, and to chat with other visitors. Once I met a small, wizened, weather-tanned herdsman leading a pony and two goats on rope halters. As we gulped from our cupped hands, a khaki-shrouded army truck rumbled past, gears gnashing, fouling the sweet air. The old man and I glanced at the truck, then at the piney hills, and finally at each other. Almost as one we shrugged and smiled sadly.

THE MILITARY OVERLAY is thick in Kashmir, and inescapable in the valley. One day I drove eastward to the little hill town of Pahalgam. There, in a deep mountain cave, stands an immense pillar of ice, worshiped by devout Hindus as a lingam representing the god Siva. The annual

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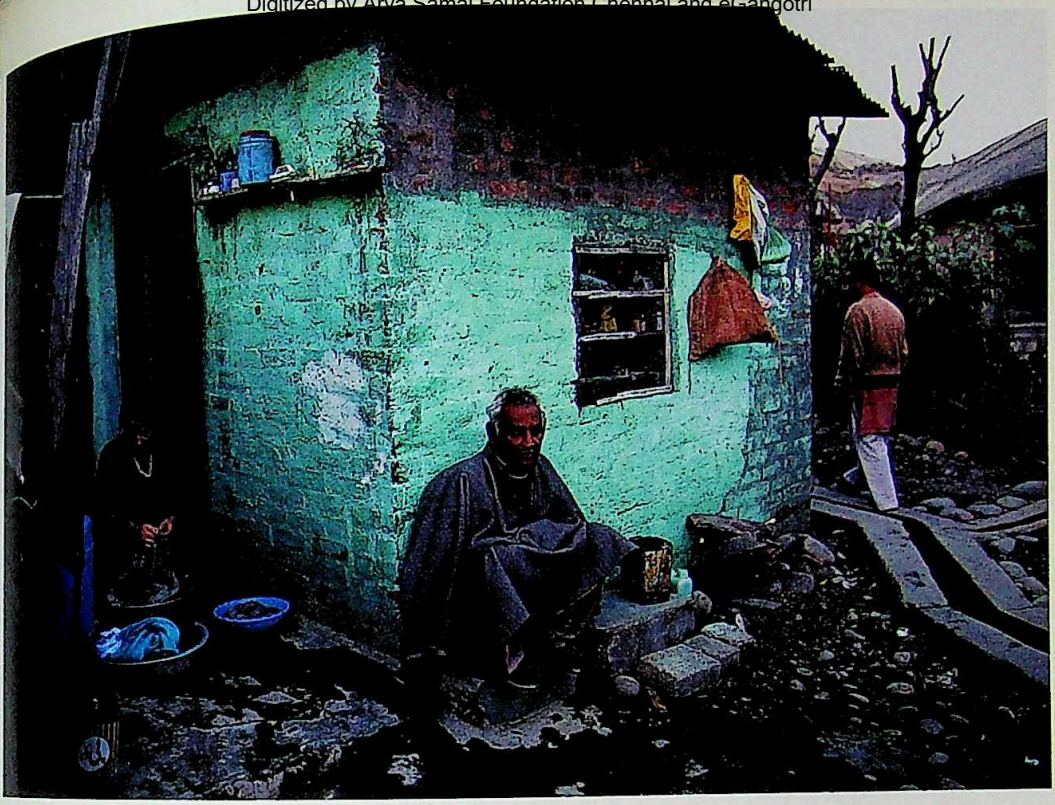

pilgrimage to this site had for several years been disrupted by the insurrection. Indian authorities, determined to demonstrate that normalcy had been restored, dispatched thousands of troops in a cordon around the devotees, who numbered perhaps 200,000. But Muslim shopkeepers hadn't hung out signs welcoming the Hindus, as in years past. The only banners strung across the road were put there by army units: "We will protect you from the militants—Indian Army Victor Force."

Another precaution taken to avoid potential outbursts was to supply the pilgrims with all the food they would need during their stay. The Hindus, many wearing the saffron-colored robes and elaborate forehead painting of the devout, stayed within their sprawling campground and away from the town's shops. Muslim merchants I talked with were infuriated as they watched buses, trucks, vans, and cars speed by, rooftops piled with bundles of food and equipment. "You see how India cares only for the Hindus," the owner of a tiny general store hissed as I sat alongside him drinking a bottle of lime-flavored Limca.

On the way back to Srinagar I stopped at a small indoor-outdoor workshop in the village of Sangam, where half a dozen men and boys were handcrafting blocks of seasoned willow cut from adjacent groves into polished cricket bats. Cricket, for which Kashmiris share the obsession left wherever the British trod, is said to be the truest measure of loyalties. When India and Pakistan play each other, Kashmiri Muslims cheer for the Pakistani side.

While admiring the workmanship of the bats, I asked the owner about his relations with the Indian troops and the Muslim fighters here in the heart of Kashmir and away from the line of control. He showed me pocks in the pale blue stucco of his shop front. "You've got to take care of both army and militants. Both come to you and demand money and food. If you refuse, they shoot the place up. That's if you're lucky." He said that he and other members of his family had been beaten in the past for refusing to comply. "So, now we give to anyone who asks."

His experience is widely shared. People all over the valley told me that everyone knew at least one family with members killed, wounded, tortured, kidnapped, or arrested by soldiers, insurgents, even next-door neighbors.

The Muslim insurgency traces back to 1987, when Indian officials rigged local elections to install their choice as chief minister, inflaming widespread resentment. In 1989 dissent exploded into a full-blown separatist

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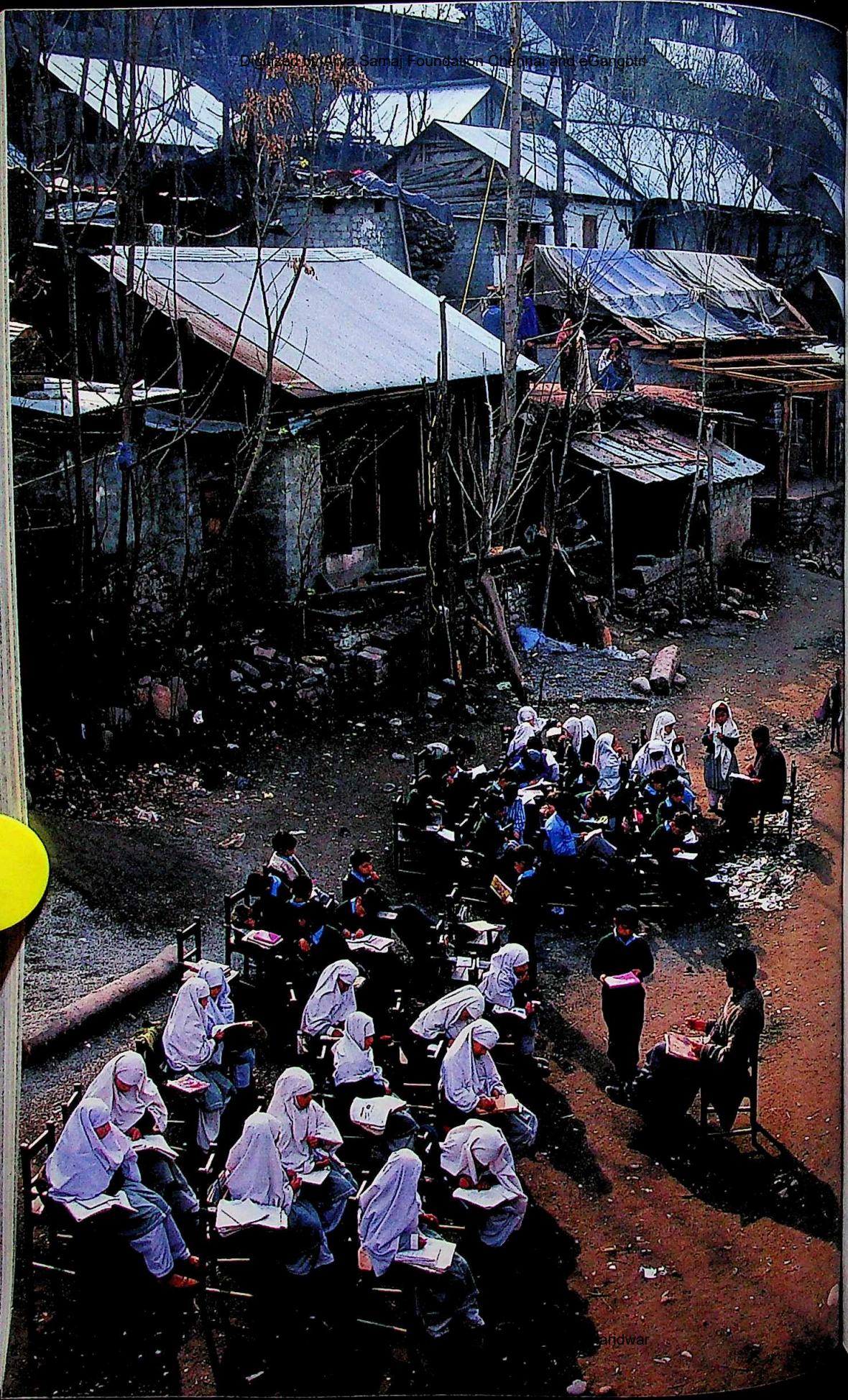

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movement, as some young Kashmiri Muslims, traditionally docile, took up the gun and began killing Indian soldiers and members of a Kashmiri Hindu community known as Pandits. The Muslim rebels imposed harsh Islamic regulations throughout Kashmir, which included burning down government schools, banning women from going out of their homes with their faces or hair uncovered, and closing movie halls and wineshops, many owned by Pandits.

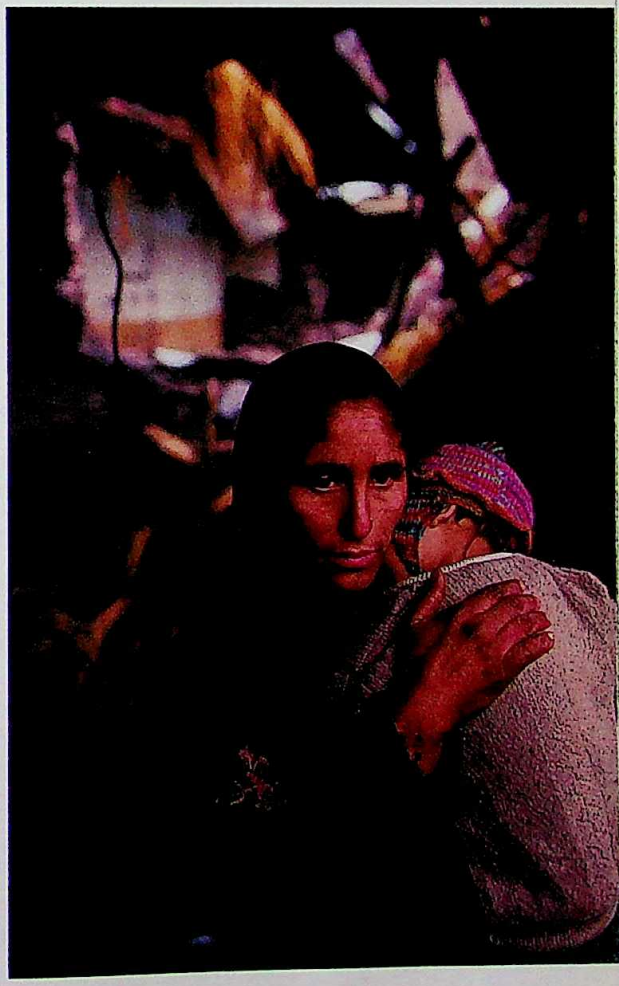
Estimates vary, but a decade ago Pandits numbered from 150,000 to 300,000 out of the eight million inhabitants of the state of Jammu and Kashmir, a small but disproportionately well-educated and successful minority. They have since been persecuted so ferociously by some of their Muslim neighbors and by infiltrating guerrillas that as few as 5,000 remain in their homes. I visited a Pandit refugee camp on the outskirts of Jammu, the capital of Jammu and Kashmir in winter, when Srinagar is cold and snowy. Jammu's Hindu residents tolerate the more than 150,000 refugees, but only just, fearing their competition for scarce government jobs. Other displaced Pandits have moved into the Indian heartland and to other countries all over the world.

ASHOK KUMAR, once a farmer, now unemployed, was a willing Pandit spokesman. I sat with him on the packed-earth floor of his allotted 14-by-9-foot room, which he shares with his wife and two children, in a long row of roughly made, single-story brick tenements. He said he had been in despair since 1990, when he fled his home northwest of Srinagar near the border with Pakistan.

"One day my Muslim neighbors came to our houses and began screaming: 'Indian dogs, leave here or die.' A few days later they raped a woman. Then they set fire to my house, and we ran for our lives. I had owned my own orchard; now I'm a beggar. The Muslims are determined to eradicate the last of this microscopic community. Why is the world deaf?"

The answer, said a young Pandit newspaper reporter who was interpreting the interview, is that for nearly all Kashmiris—Hindu and Muslim, on both the Indian and Pakistani sides—life is so filled with atrocities that the "ethnic cleansing" the Pandits feel is being waged against them is a barely audible subtext. "My entire family were burned out of our homes," the reporter told me. "My cousin was murdered. All of us, all Kashmiris, are victims." Kumar, the Hindu Pandit, like Muzaffar Shah, the Muslim I'd met fleeing his village of Tafarabad on the Pakistani side, was just one more victim of the struggle for Kashmir.

Many of those who die in the turmoil are buried in "martyr cemeteries," rows of white marble slabs, often festooned with gold and silver tinsel, dotting cow pastures and soccer fields, country roadsides and city traffic



A mother comforts her child in what was once their home. India and Pakistan deny targeting civilians, but shell-struck towns litter the border. Raising their children in Pakistan's refugee camps, Kashmiri parents rely on makeshift schools (opposite) to help preserve a Muslim heritage that faces growing hostility in India.

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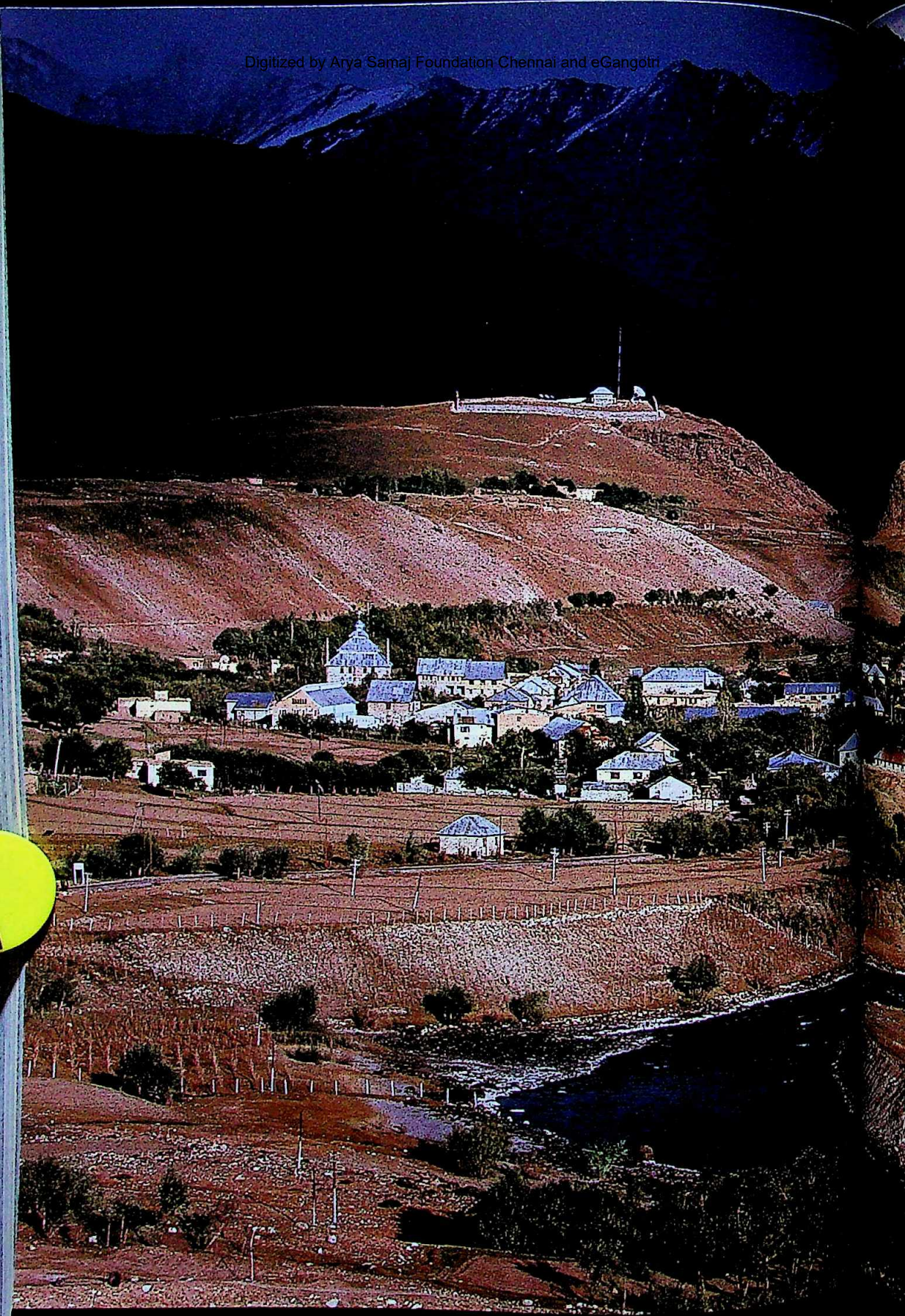

Dras huddles on India's side of the line of control beneath Himalayan heights where guerrillas infiltrating from Pakistan became a target of Indian air strikes

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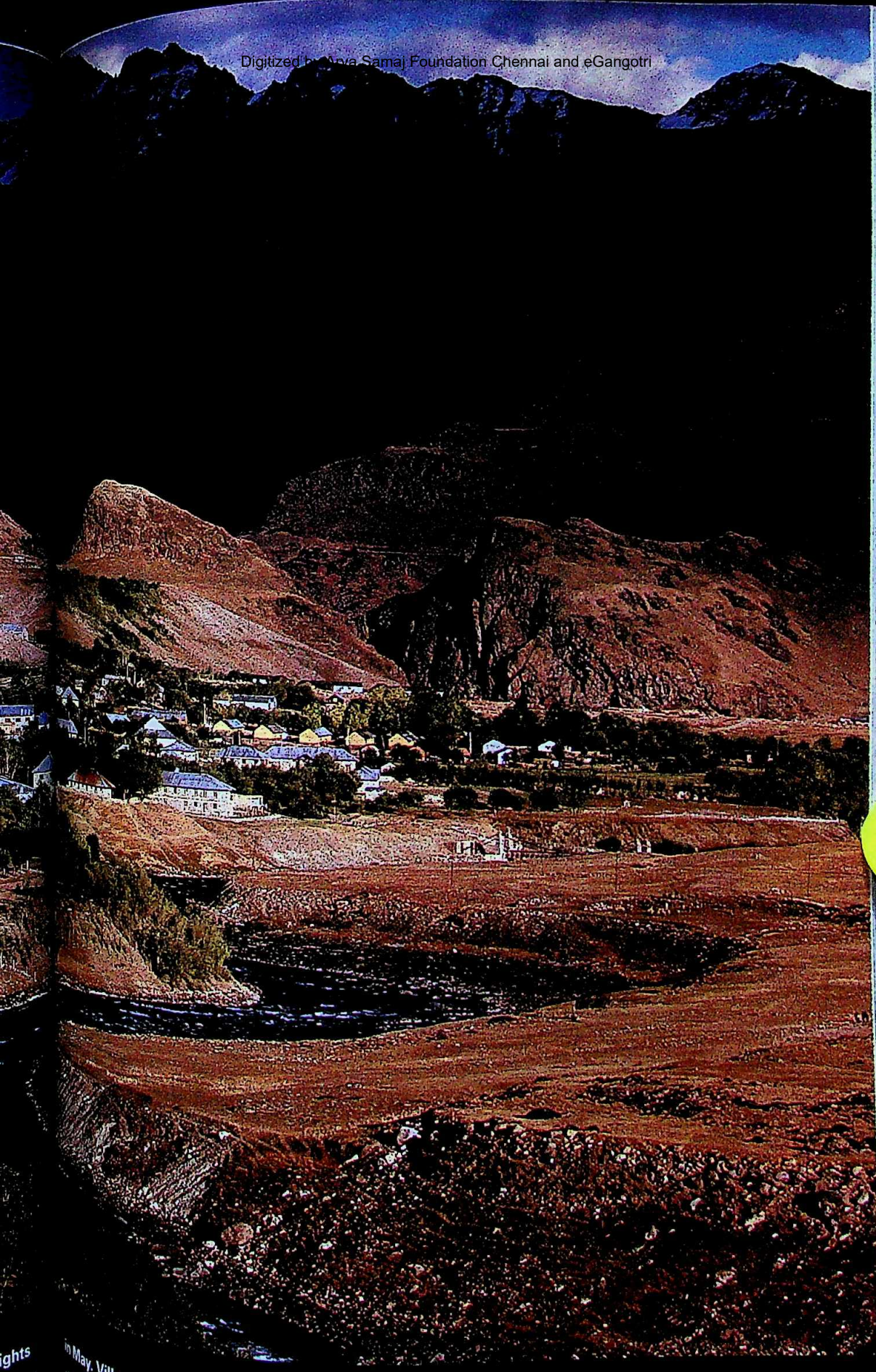

ights
strikes

in May. Villagers fled as fighting intensified and Pakistan, in sympathy with the "indigenous freedom fighters," retaliated with artillery bombardment.

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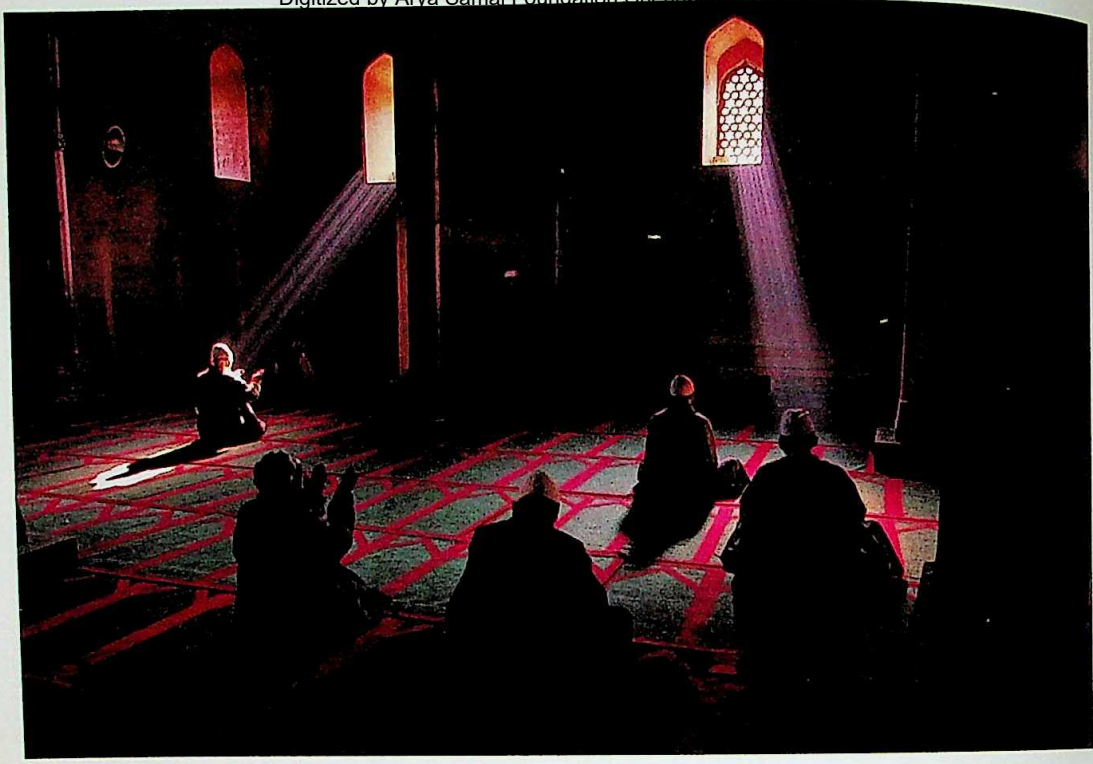

The devout gather under the carved wood windows of Srinagar's largest mosque, Jamia Masjid (above). Since the 14th century the city's Muslim faithful have come here to pray. Asiya Andrabi (opposite, standing) exhorts the Dukhtarani-Millat—Daughters of Faith—to press for Kashmir's union with Pakistan. She continues despite a year and a half spent in an Indian prison for such secessionist agitation.

islands. At noon one day in Srinagar I found a 23-year-old Muslim man, a slim, sad-eyed tailor, strolling barefoot among the markers in a graveyard. He was paying respects to a slain religious leader. "The government of India is responsible for this," he said.

While Muslim Kashmiris share this condemnation of India, they have begun to distance themselves from Pakistan. They gladly accept money, arms, and guerrilla fighters from Pakistani extremist groups, but few say any longer that they want Kashmir to become a part of Pakistan.

Pakistan's leaders deny giving the rebellion material aid, but a Muslim leader I spoke with in Rawalpindi confirmed that money originating in Saudi Arabia and Iran is funneled through Pakistan to the militants in Kashmir. The money is also used to pay Islamic fighters —among them Pakistanis, out-of-work Taliban zealots from Afghanistan, and other soldiers of fortune from as far away as Libya and Chechnya—who infiltrate the Indian-held side on the pretext of waging jihad, holy war.

Yaseen Malik, 32, a prominent Kashmiri militant who says he's cut his ties to Pakistan, is famed among his followers for killing four Indian air force personnel and an official of the government-run television network in the early days of the uprising. He suffered a stroke that left the right side of his bearded, boyish-looking face partly paralyzed. After spending four years in a New Delhi jail, he was released but remains under close surveillance.

Malik has about him an almost beatific air. He neither boasts about, nor apologizes for, his past. Rather, he discusses what Kashmiris term "the militancy" in even, direct tones. When he spoke to me in downtown Srinagar in the sparse second-story office of his Jammu and Kashmir Liberation Front—one of a dozen or so competing militant groups—he was dressed in simple white cotton trousers and tunic. Aides, bearded men his own age, stood around the brightly lit, pea green room, glancing out an open window onto the sputter

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and jangle of city traffic. Malik kept a cigarette burning much of the time, clenched near the knuckles of index and middle fingers, sucking the smoke from the top of the fist, in the manner of many Kashmiri men.

We sat opposite each other, barefoot and cross-legged on a red carpet. His voice was at times barely audible, and he seemed exhausted. But, he insisted, despite government claims of restored normalcy in Kashmir, the relative calm of the moment masked "only our time of hibernation, of rebuilding our strength. It's true that Kashmir is bleeding, but so is India. If they don't take our independence struggle seriously, full-fledged violence will return."

Not surprisingly, given their recent history, Kashmiri Muslims yearn for independence. Even without the turmoil of recent decades their desire would be understandable, for they were once a self-contained people, evolved mainly from Central Asia and Persia, with characteristically fair skin, light eyes and hair, their own interpretation of Islam, a distinct language, architecture, and style of dressing.

The few Indians who take Kashmiri separatism seriously are those who know the most about the place and its people. A senior Indian administrator in Srinagar, who spoke candidly only when I agreed not to use his name, put it this way: "The truth is that the Kashmiri does have a case. He says, 'Give me my rightful place in the sun, give me my dignity, my religious sensibilities, my cultural identity. Don't impose yourselves on me.' That's legitimate. But the militants are chasing up a blind alley when they go in search of *azadi* [independence]. We will never grant them independence. Never. India is a hard state."

India feels obliged to show Pakistan its intention to bend Kashmir to its will. After years of street battles Indian troops had weakened the separatist militants to the extent that touches of daily life had recovered. Schools were open. Lal Chowk market in central Srinagar was packed with jostling women, some hidden inside voluminous *burkas* in deference to the militants, others having reverted to the more liberating Kashmiri-style robes and headdresses. Butchers casually waved flies from hanging mutton joints, and most goods were in ample supply. At a fruit stall a woman accepted an apple slice proffered by the vendor and gave it to her small son. Averting her luminous green eyes as I asked her how life was these days, she replied without hesitation, "Oh, there's

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no question that things are better. We're able to walk about without worry and to shop for our daily needs."

On Sundays families arrive by the busload at the splendid Mogul gardens near Dal Lake to indulge their fondness for picnics. Photographers encourage couples to pose in richly colored period costumes, and vendors entice children with balloons and ears of roasted corn. A young couple, she in a loose, pumpkin-color robe, he in a sky blue safari suit, were sitting near a trickling stream, eating ice-cream cones. "This is the first time we've come to the gardens in some years," said the man, licking at his droopy mustache. "But just because you can go out for a few hours hardly means that life is normal, which is what the government says." Then, showing me a pale scar running from his left ear to the corner of his mouth, he said, "This is what the soldiers did to me." He'd been caught in the cross fire between Indian troops and some militants, but he blamed only the soldiers.

As if to illustrate his point, plainclothes security men appeared shortly before dusk and, casually swinging machine guns, began ushering stragglers out of the gardens. Movie theaters in the city were still closed, banned by the militants, as were liquor shops and bars. Most tourist hotels, and a good many abandoned Pandit-owned houses, were being used as troop billets, their balconies hung with laundered uniforms, their entrances sandbagged. There was little call for hotel space. At the Palace Hotel overlooking Dal Lake, once the maharaja's residence and now under reconstruction, I was the only guest most nights. Rebuilding the palace was an act of faith. "*Inshallah*—God willing—tourists will begin coming back to Kashmir, perhaps next year," a lonely clerk at the front desk said one evening. Then, hesitantly, "Don't you think so?"

It seemed unlikely. It has taken India nearly a decade to limit the revolt, and in doing so soldiers raped, tortured, illegally detained, and robbed thousands of Kashmiris, according to international human rights organizations. The Indian Army has weakened the militants, but people are by no means ready to forgive, nor to forget the dream of independence. And so Kashmir remains an armed camp, in which not even the simplest farmer is free to come and go.

HARVEST SEASON in the valley, and roads are clogged with tiny pony carts heaped high with wooden apple crates. Troops halt the drivers and search for explosives. At the dingy public hospital in Uri, Aijaz Iqbal Beigh, a tall, thin man with a scraggly brown beard, says the 40-mile bus ride from his village, Lalpor, has taken six hours. "The soldiers checked us every 200 meters," he says. "Ladies, gents, even children are checked."

Early any morning I'd run into a logjam of armored vehicles loaded with troops, their heads swathed in black scarves, adding to their already sinister appearance, and an anxious-looking soldier with his finger on the trigger of a heavy machine gun. Slowing their progress would be a sapper unit, men on foot sweeping with electronic devices, accompanied by Alsatian dogs sniffing for buried mines. "You just don't know when a sniper might squeeze off a round or two at you or when you might find a mine," a muscular lieutenant wearing the starched olive drab turban of a Sikh told me, leaning from the cab of his truck.

Although India and Pakistan seem incapable of coming to a resolution, it's not for want of talking. As I was witnessing the shelling across the LOC near Uri, political leaders were attending a South Asia regional conference in Sri Lanka—discussing Kashmir. The outcome: There would be another round of talks.

In much the way that Tibetans have been forcibly surrounded by the dominant Han culture of China, Kashmiris are being subsumed by India and used by Pakistan. In both places, as in other parts of the world where larger powers determine the fate of smaller ones, the land matters more than the people. With no other country willing to intervene on behalf of the Kashmiris, it is evident that they have no way out. □

A flower seller paddles through Dal Lake's quiet waters. Few observers expect diplomacy to restore equal serenity to his homeland. Buffeted from within and without by waves of seemingly intractable strife, Kashmir faces a stormy future.

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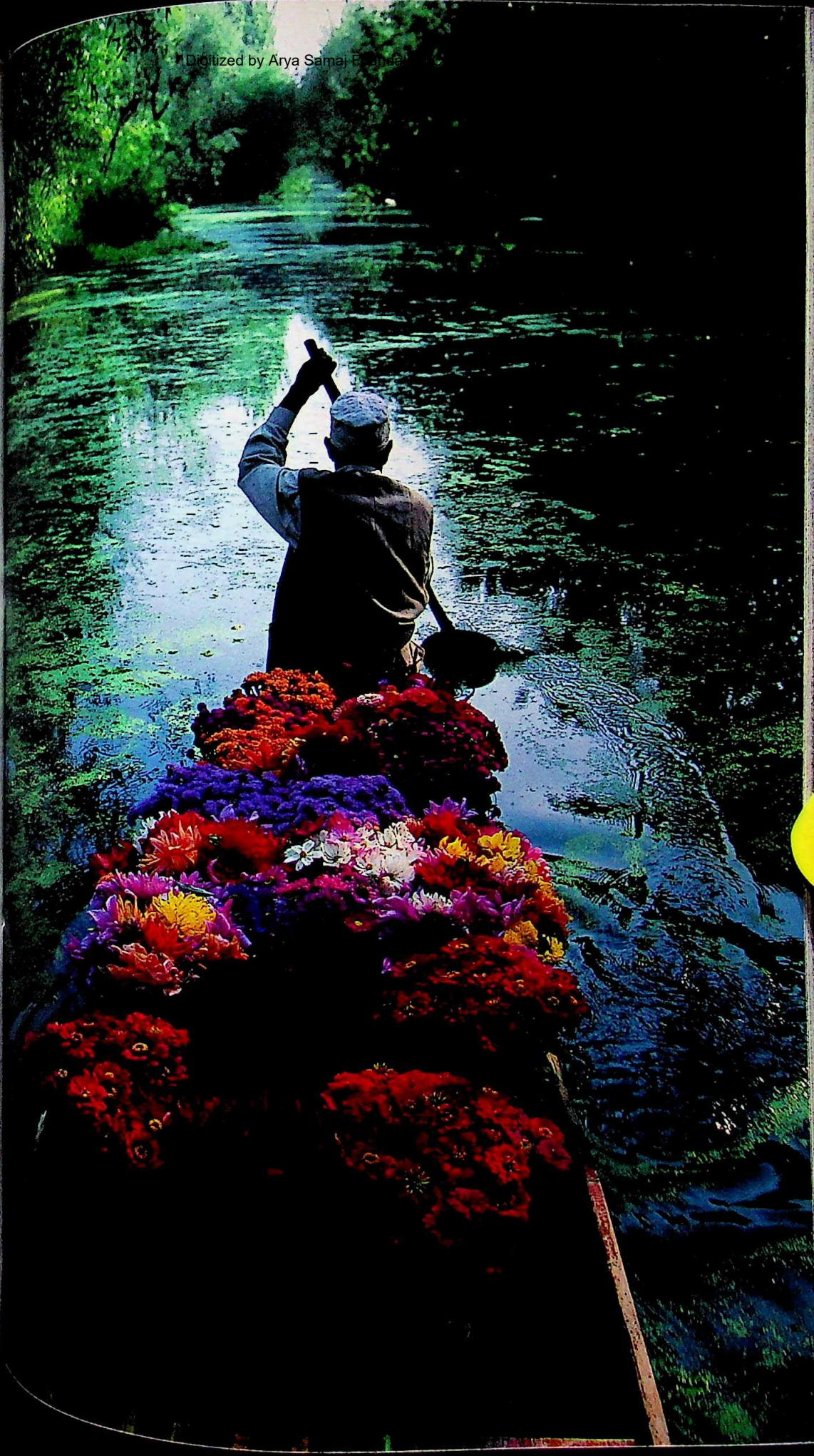

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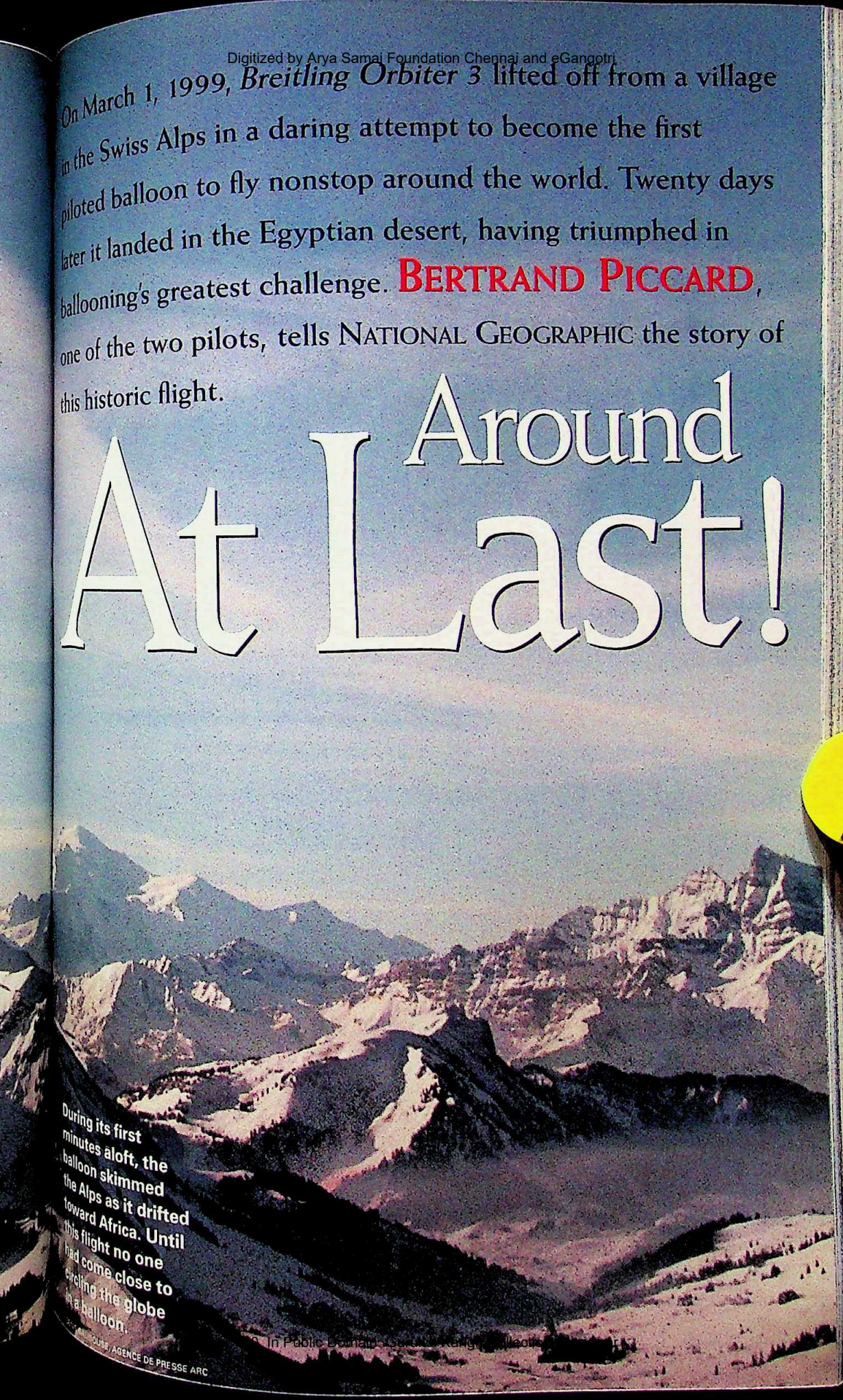
On March 1, 1999, *Breitling Orbiter 3* lifted off from a village in the Swiss Alps in a daring attempt to become the first piloted balloon to fly nonstop around the world. Twenty days later it landed in the Egyptian desert, having triumphed in ballooning's greatest challenge. **BERTRAND PICCARD**, one of the two pilots, tells NATIONAL GEOGRAPHIC the story of this historic flight.

Around At Last!



During its first minutes aloft, the balloon skimmed the Alps as it drifted toward Africa. Until this flight no one had come close to circling the globe in a balloon.

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High above the red vastness of the Sahara, the silver bubble of the *Breitling Orbiter 3* balloon feels absolutely motionless. Only our instruments tell us we are moving: 85 miles an hour. Yesterday Brian and I climbed out the hatch. As he fixed a problem with the burners, I used a fire ax to break off ten-foot-long icicles that had formed on both sides of the capsule, watching them tumble and turn as they fell toward the impossibly empty sands of Mali below. After closing the hatch, we repressurized the capsule, fired our burners, and climbed back to our cruising altitude of 23,000 feet. Now, sitting in the cockpit in front of our navigation instruments, we smile at each other. After flying southwest for three days, we have reached the 25th parallel and entered the jet stream at last. For the first time since March 1, when we took off from Switzerland, my home country, we are heading east. We can finally say that our trip around the world has started.

For me this flight is a unique opportunity to establish a friendlier relationship with our planet. Human beings always want to control nature, but to fly around the world by balloon, even using our most advanced technology, we must harmonize with nature, following the rhythm of the wind. Unlike my previous two attempts to circle the globe, this time I feel that my dream is within reach. Our Rozière balloon, a combination hot-air and helium design, is flying well and is using less propane fuel than expected. The engineers at Cameron Balloons, who built the envelope and capsule, have done an excellent job. And Brian Jones is the best partner I could have chosen. With a calm and flexible personality, he is also a fine technician and a very good pilot. But as I look down at the arid surface, images flash before my eyes of all the problems, all the failures, and all the tears we have gone through to reach this point.

In January 1997, when Wim Verstraeten and I made our first round-the-world attempt, our balloon had barely taken off before a massive fuel leak covered the floor of our pressurized cabin with kerosene, making us sick with vapors and forcing us to ditch in the Mediterranean Sea. On our second flight, in January 1998, Wim, Andy Elson, and I managed to reach Myanmar (Burma), but an

Grinning through three-week-old whiskers, Piccard, far right, and copilot Brian Jones rejoice after being picked up in the Egyptian desert. "We took off as friends and landed as brothers," the author said of Jones. In recognition of the flight, the pair will be awarded the Hubbard Medal, the Society's highest honor.

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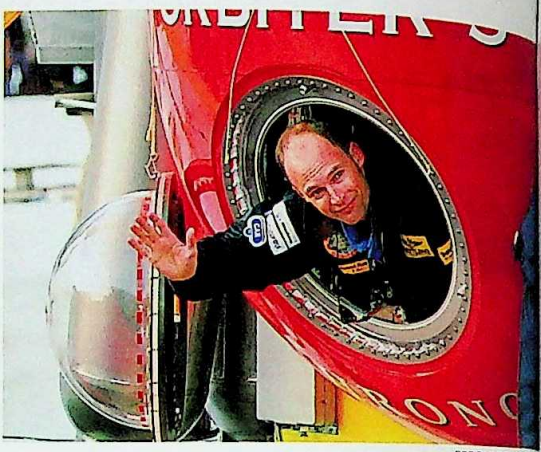
A family tradition: Like grandfather, like

KEYSTONE-UNDERWOOD



BREITLING SA

Speaking to the press in Zürich on August 18, 1932, the author's grandfather Auguste Piccard explains the scientific mission of his second balloon flight into the stratosphere, studying cosmic rays. The author, waving from his capsule before the launch, sounds more like the psychiatrist that he is. He describes his own flight as "a fabulous metaphor for life—finding new resources to face the unknown."

THAT MORNING at the Swiss village of Château-d'Oex, when Brian and I climbed into the capsule, the wind began to buffet the balloon and rattle our 32 propane fuel tanks. Brian looked a bit pale, but I was fatalistic: There was no going back. The uproar of the thousands of spectators drowned out the voices on our radio, and a burst of wind shot us upward. The last line tethering us to the ground had been cut.

We knew the first 24 hours would be crucial. In many previous round-the-world attempts problems had appeared quickly. I could also not forget the story of my grandfather Auguste Piccard, when he took off on his first flight into the stratosphere in 1931. A whistling noise showed him there was an air leak in the wall of the cabin. He finally managed to plug the leak with hemp and Vaseline, but later he found unexplained loss of fuel during the first night and a lack of permission to fly over China put an end to that attempt. We stayed aloft longer than anyone had before, 9 days and 18 hours, but still we failed.

That flight had proved, above all, how important China was to our plans. Without permission to cross the Middle Kingdom, which stretches across so much of Asia, our chances would be slim. So in August 1998 I flew to Beijing with three other members of the team to persuade Chinese officials and obtained an overflight permission two months later.

By the end of November the balloon was ready to fly. But then the global weather patterns turned bad, Iraq was being bombed again, and a British balloon drifted over forbidden areas of China, prompting the Chinese to withdraw permission for our flight as well. The season for round-the-world ballooning, which takes advantage of winter's more constant jet streams, was almost over by the time Swiss diplomats obtained a new approval for us to fly over China—but south of the 26th parallel to avoid sensitive or unsafe areas. That promised to be a difficult feat, since no weather pattern could guarantee such a trajectory. Nevertheless, on March 1 our meteorologists, Pierre Eckert and Luc Trullemans, gave us a green light to launch.

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Digitized by Arya Samaj

like grandson

that he was unable to descend because of a release-valve cord that had become tangled. He had to wait for the night to cool his balloon in order to get back to Earth.

For Brian and me, crossing the Alps was slow but wonderful. We had a spectacular view of the Matterhorn and Mont Blanc. That evening, with the sun setting over the Côte d'Azur, we enjoyed a meal of emu steaks, rice, and vegetables, reheated in plastic bags in the kettle.

The following afternoon we passed Almería, Spain, where Colin Prescot and Andy Elson had launched *Cable & Wireless* two weeks before on their own round-the-world attempt. We had no hope of catching up with them though, since they were already over Myanmar 6,000 miles away.

Now, on the fifth day of our flight, my face is glued to the porthole as we soar over Libya. I have begun to like this desert, which 70 years ago was crossed by Antoine de Saint-Exupéry, Jean Mermoz, Henri Guillaumet, and the other pilots of the French Aéropostale whose works I read when I was a child. Suddenly the satellite fax light blinks, and a message from our control center in Geneva appears on the computer's screen.

"Our current speed of 85 miles an hour is too fast. The stream is going to take us north of the Himalaya. Let's descend to slow down and take a more southern route." Our friends in the control center have such team spirit that their messages are often written in the first person. They are all flying with us, from Alan Noble, the flight director, on down. Even though we are still four days from China, Alan is already worried. He knows we must cross the border into China at exactly the right place.

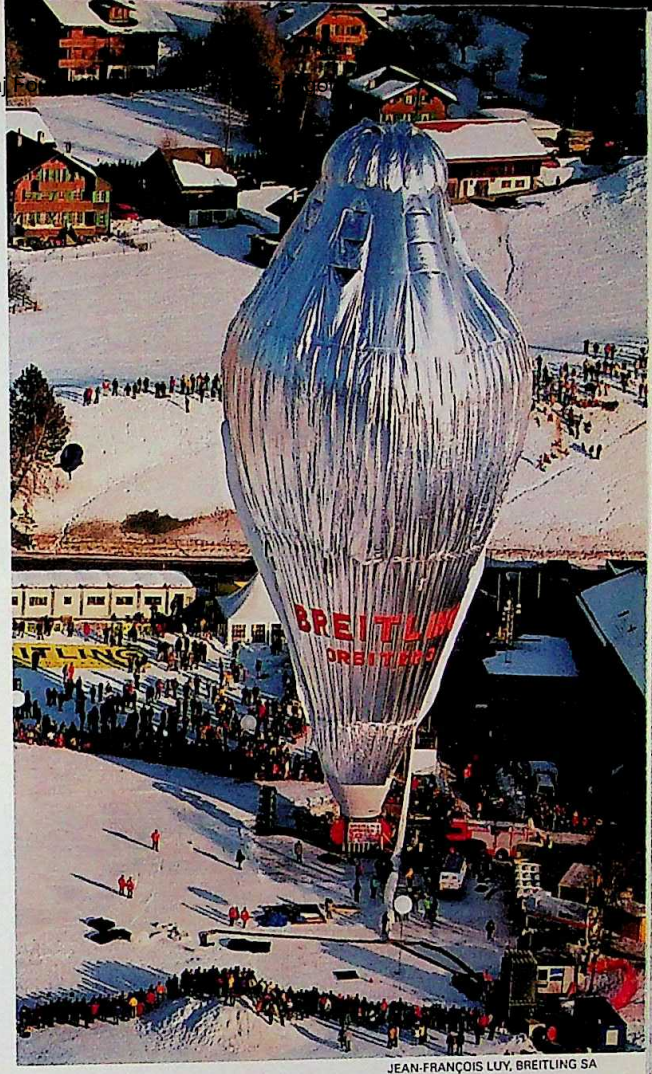
Thanks to our new altitude, we drift toward southern Egypt, over Sudan, Saudi Arabia, Yemen, Oman, then India and Bangladesh, assisted from afar by Swiss air traffic controllers, who help us gain access to forbidden areas. Not all the countries we fly over understand our goal, as shown by this radio exchange between Brian and the Burmese authorities:

"This is Rangoon control. What are your departure and landing points?"

"HB-BRA, departed from Switzerland, intention to land somewhere in Africa."

"If you're going from Switzerland to Africa, what in the hell are you doing in Burma?"

Each day Brian and I take eight-hour shifts in the pilot's seat. While one of us flies the balloon, the other crawls beneath the covers in the bunk to sleep. We spend the rest of the time together, plotting our



JEAN-FRANÇOIS LUY, BREITLING SA

In a sheltered valley in the Swiss Alps the 180-foot-tall balloon lifts off from the snow-covered ground in the village of Château-d'Oex at 9:05 a.m. local time on March 1, 1999. Weeks earlier the launch had been delayed until Swiss diplomats could obtain permission for the balloon to cross China.

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JOFFET EMMANUEL, SIPA

Their lifeline to the surface, a laptop computer allows the pilots to trade messages with mission control in Geneva. Piccard adjusts a tiny camera for sending pictures as well.

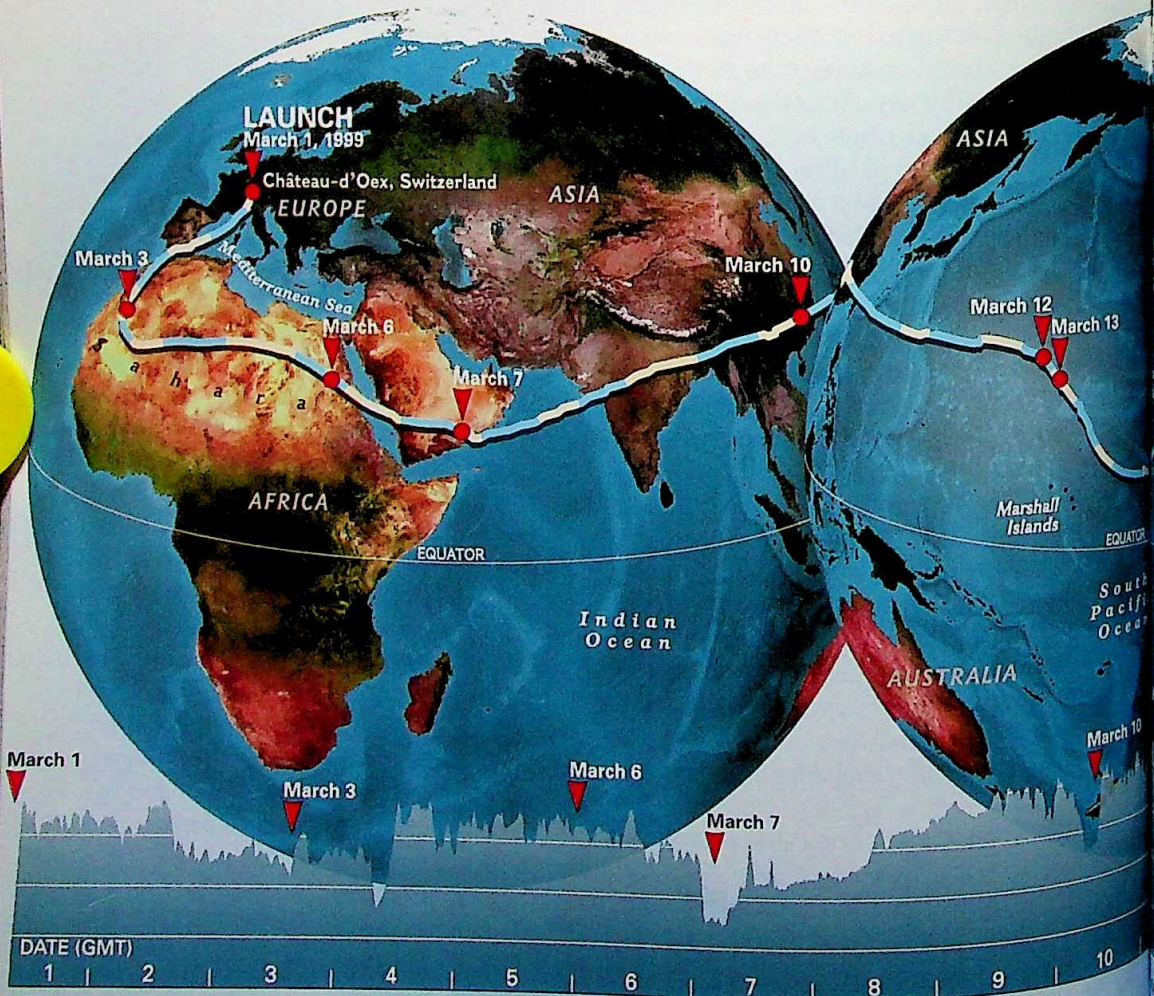
route on maps, discussing flight strategies, making repairs, preparing food in the tiny kitchen area.

After nine days in the air, we are ideally positioned to enter southern China. Crossing the border in the middle of the night, we cannot see the high mountains of Yunnan Province, but we feel their effect: Huge waves of wind make the balloon difficult to stabilize. The first words of the Chinese air traffic controller leave us no doubt.

"HB-BRA, remember, it is forbidden to fly north of 26 degrees."

Back at the control center in Geneva the atmosphere is electric as they follow our progress. At one point, when we drift as close as 25 miles to the restricted area, the Chinese authorities ask us to prepare for an emergency landing. But as if by a miracle the wind brings us back on track. The next morning when the sky brightens, we see a China that is almost completely covered by a thick layer of clouds. During the rest of our 15-hour crossing we keep our eyes fixed on the magic numbers of our instruments: 85 miles an hour, heading

Breitling Orbiter 3 Route



March 1, 1999
Balloon launches from Château-d'Oex, Switzerland, at 8:05 a.m. Greenwich mean time (GMT).

March 3
Having drifted southwest from the start, Piccard and Jones finally begin to turn toward the east.

March 6
After zooming over Libya at almost 90 mph, the balloonists must avoid no-fly zones over Egypt and Yemen.

March 7
Piccard and Jones learn that rival British balloonists Andy Elson and Colin Prescot have ditched off Japan.

March 10
Honoring an agreement with China to stay south of the 26th parallel, the team crosses that nation in 15 hours.

March 12
Wary of towering nimbus clouds, the pilots continue their six-day journey across the Pacific Ocean.

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In Pursuit of the Dream

Below are ten of the most notable round-the-world attempts in ballooning's history.

Mar. 1-21, 1999 ***BREITLING ORBITER 3*** (40,814 km/25,361 mi)

Feb. 17 - Mar. 7, 1999 ***CABLE & WIRELESS*** (14,408 km/8,953 mi)

Dec. 18-25, 1998 ***ICO GLOBAL*** (19,962 km/12,404 mi)

Aug. 7-16, 1998 ***SOLO SPIRIT 3*** (22,910 km/14,236 mi)

Jan. 28 - Feb. 7, 1998 ***BREITLING ORBITER 2*** (8,473 km/5,265 mi)

Dec. 31, 1997 - Jan. 5, 1998 ***SOLO SPIRIT 2*** (9,337 km/5,802 mi)

Jan. 14-20, 1997 ***SOLO SPIRIT*** (16,674 km/10,361 mi)

Jan. 8-10, 1996 ***SOLO CHALLENGER*** (2,927 km/1,819 mi)

Nov. 7, 1982 ***JULES VERNE*** (1,870 km/1,162 mi)

Jan. 11-13, 1981 ***JULES VERNE*** (4,302 km/2,673 mi)

NATIONAL GEOGRAPHIC MAPS
SOURCES: CAMERON BALLOONS; BREITLING SA; NOAA SATELLITE MOSAIC PREPARED FOR NATIONAL GEOGRAPHIC TELEVISION BY JPL AND RENDERED BY NASA'S LABORATORY FOR ATMOSPHERES; HANS AKERSTEDT, FEDERATION AÉRONAUTIQUE INTERNATIONALE (CHART ABOVE)

Varying wind speeds account for unequal periods of day and night on the route map.

March 13
The balloon passes the half-way mark near the Cape Verde Islands.

March 16
The pilots surpass American Steve Fossett's distance record of 14,236 miles.

March 17
The balloon is ejected from the jet stream over Mexico.

March 19
Piccard and Jones break the duration record of 17 days, 17 hours, and 41 minutes aloft.

March 20
The balloonists cross the finish line at 9°27′ west longitude, becoming the first to circle the globe nonstop.

March 21
Piccard and Jones land safely in Egypt at 5:52 a.m. GMT.

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BRIAN JONES AND BERTRAND PICCARD

The first bear to circle the globe in a balloon was a gift to Jones from an airline flight crew, who suggested that the high-flying teddy be auctioned later for charity. Beaming at his own contraption, the author demonstrates a window-cleaning tool he fashioned during the flight from sponges, a radio antenna, and a boat hook. Later he chips ice that formed on the fuel valves from the condensation of moisture in the cabin air.

90 degrees. For 1,300 miles we have followed a straight line.

As soon as we leave China, the crew in the control center opens the first bottles of champagne. To them we have achieved the most difficult challenge of the trip. Yet we still have two oceans to cross, as well as North America.

The decision to cross the Pacific Ocean is irreversible. Ahead lies 10,000 miles of water, and the team in Geneva does not seem certain where to send us. Three days earlier we had all been shocked to hear that Colin Prescot and Andy Elson had been forced by bad weather to ditch their balloon in the Pacific off Japan. We were greatly relieved to learn that they were safely rescued—and to realize that we were now the only round-the-world balloon in the air. But the same storm that downed their balloon is still threatening.

Finally we receive a message advising us to give up on the northern route and to let ourselves be pushed south toward the Equator, where the computer models predict a jet stream will form in three or four days.

We don't know what to expect. No one has ever flown a balloon so far south across the Pacific.

"We have no choice," I say to Brian.

THAT AFTERNOON, as we fly past the Mariana Trench, the deepest spot on the planet, I think of my father, Jacques, who 39 years ago rode his bathyscaph to a depth of 35,800 feet. Considering my grandfather's exploration of the stratosphere and my father's journeys into the ocean abysses, I have begun to dream that my own flight around the world might fulfill our family's destiny—if there is such a destiny. Thinking about such things only increases my fear of failure. And yet I realize that I must learn to let go of my anxiety, to have confidence in life as I have tried to have in the wind.

All around us the clouds seem alive. Every morning small cumulus clouds appear next to the balloon, growing little by little until they become fearsome cumulonimbus storms, able to tear the fragile skin of our balloon in their turbulence. As if guided by an invisible hand, we weave *(Continued on page 43)*

BRIAN JONES (LEFT AND ABOVE)

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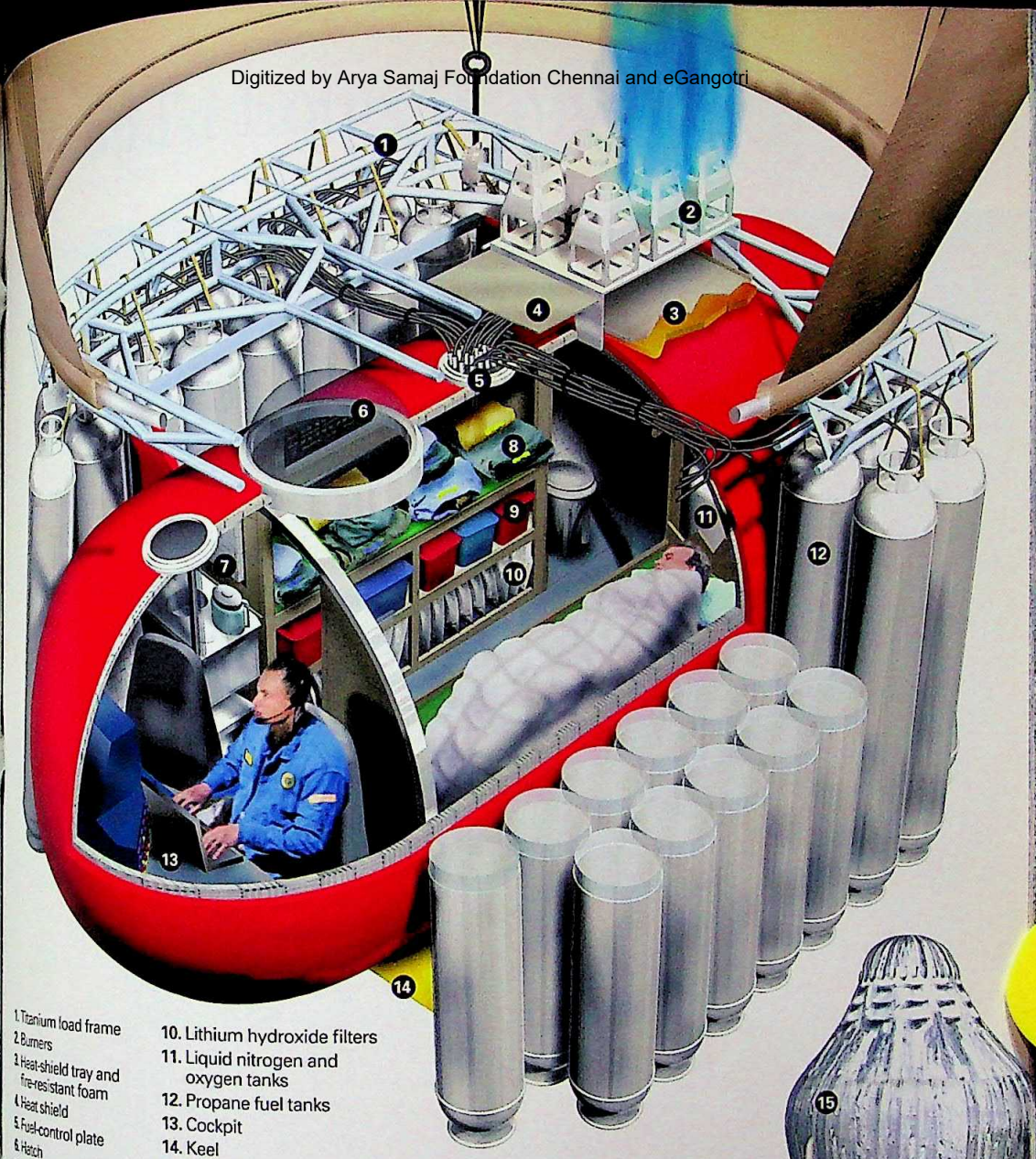
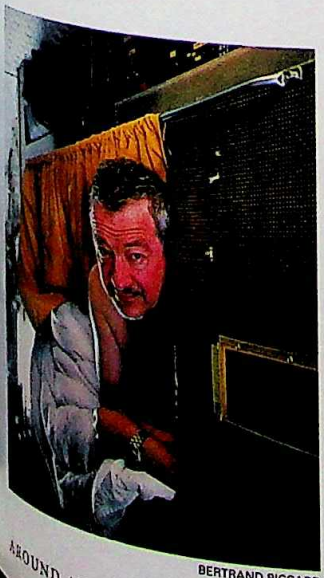


1. Titanium load frame
2. Burners
3. Heat-shield tray and fire-resistant foam
4. Heat shield
5. Fuel-control plate
6. Hatch
7. Kitchen
8. Survival equipment
9. Food supplies
10. Lithium hydroxide filters
11. Liquid nitrogen and oxygen tanks
12. Propane fuel tanks
13. Cockpit
14. Keel
15. Mylar outer skin
16. Solar panels

ART BY DON FOLEY



BERTRAND PICCARD

Life in the Capsule

About the size of a minivan, the 18-foot-long *Breitling Orbiter 3* capsule was designed to keep two pilots comfortable for four weeks. Jones (left) and Piccard took turns sleeping in one bunk, using the other for storage. The cabin, pressurized to fly as high as 40,000 feet, had an air recycling system that added oxygen and removed excess carbon dioxide with lithium hydroxide filters. Using the fuel controls, the pilots could operate the burners, switch tanks, and jettison empty tanks from inside. Keels gave the capsule a flat base and would aid flotation in case of a water landing. Solar panels recharged batteries under the cockpit floor, powering equipment, lights, and a kettle in the kitchen.

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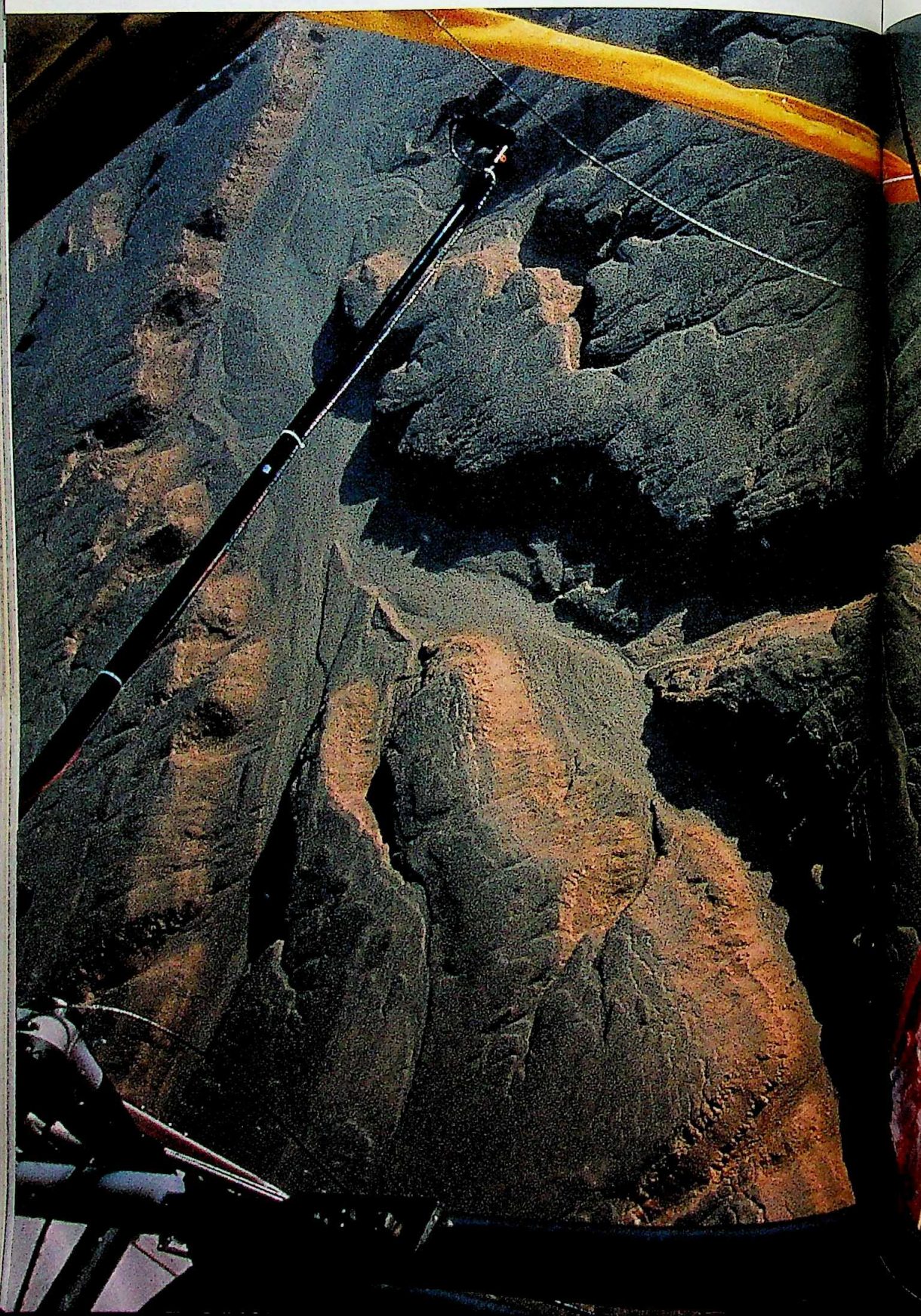
These are the



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are the longest hours of my life.

Hours after crossing the finish line at 9°27′ west longitude above West Africa, the balloonists descend toward Egypt's Western Desert, looking for a safe place to land.

BRIAN JONES AND BERTRAND PICCARD

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Back to Earth after 20 days. The

With less than a tank of fuel, the pilots make a two-bounce landing on a sandy plateau near the Egyptian oasis town of Mut. A seven-hour wait to be picked up by a military helicopter gave them time to wash their hair and consider their historic flight. "When Neil Armstrong stepped on the moon, he was happy to be so far away," the author says. "When we stepped onto the desert, we were happy to put our footprints back on Earth."

AP/WORLD WIDE PHOTOS (TOP); BRIAN JONES AND BERTRAND PICCARD (RIGHT); GAMMA-LIAISON (LOWER RIGHT); BERTRAND PICCARD

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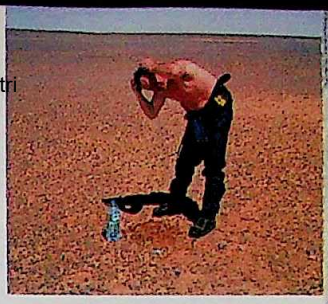
days. The *Eagle* has landed.



among the thunderclouds, which dissolve every night in the coolness of glorious sunsets.

When our speed drops to 25 miles an hour, we become very concerned, since we have covered less than 3,000 miles of ocean. We are flying so close to the Equator that the aluminum coating of the balloon over our heads blocks communication between the antenna on our capsule and the satellite directly above. We lose our fax and telephone links with our team.

"Brian, I have to tell you I'm a little frightened," I say.

"I'm really pleased to hear you say that," Brian replies, "because I'm really scared."

This immense expanse of ocean has become a mirror in front of which it is impossible to fool myself. I feel naked with my emotions, my fears, and my hopes. We'd like to be farther on in our flight, but all we can do is accept being where we are, drifting in a lazy wind over the biggest ocean on the globe.

AFTER SIX DAYS of flight over the Pacific, the optimism of our meteorologists is proved right and we enter a powerful jet stream. Now, at 33,000 feet, we are delighted to race toward Mexico at 115 miles an hour. The typical cirrus clouds of the jet streams accompany us, their ice crystals glistening in the bright sunlight. But the euphoria lasts only 24 hours. At this altitude the outside temperature is minus 58°F, our burners use a lot more propane, and our cabin heater becomes less efficient. The water reserves inside the capsule have turned to ice.

Cold and exhausted, Brian and I begin to pant in the overdry air of the cabin. Worse, we watch, powerless, as our speed drops: Somehow we have been ejected out of the jet stream over Mexico and are flying the wrong way, southeast toward Venezuela.

Wearing oxygen masks, Brian and I take turns sleeping as much as we can to regain strength. Completely out of breath, I phone my father and my wife with tears in my voice. My dream is falling apart, I tell them. So close to our goal! I decide to risk everything. We will fly as high as the balloon can take us, no matter how much propane it takes, to try to get into a jet stream that Luc and Pierre have managed to locate. According to them, the whole flight depends on it. At 35,000 feet my eyes are fixed on the instruments, and I can barely believe what

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An invisible hand guided us.

AP/WORLD WIDE PHOTOS

Back in the embrace of their families, the pilots celebrate their return to Switzerland, where they are hailed as conquering heroes. Yet the secret of their success was not to conquer but to harmonize with the winds, Jones says, recalling a balloonists' prayer. All they had to do was "let Mother Nature take us in her arms, carry us around the world, and set us gently back down again."

I see: Degree by degree, our flight curves northeast. A bit later Brian notices that our speed is dramatically increasing. After flying over Jamaica, we are back on track.

On March 18 we have only four fuel tanks left out of 32, barely enough to cross the Atlantic. But there is no way we are going to stop our flight in the Caribbean. I remind Brian of what Dick Rutan, who flew nonstop around the world in an airplane, once wrote me: "The only way to fail is to quit." By the next day we are halfway across the ocean, flying at 105 miles an hour in the middle of a jet stream.

We cross the coast of Africa during the night, and when the sun rises on March 20, we are just a few hours away from Mauritania. These are the longest hours of my life. Western Sahara stretches in front of my eyes. I am happy to see the red sand desert again.

AT 9:54 A.M. GREENWICH MEAN TIME Brian and I look at our maps incredulously: After having flown 26,050 miles, we have reached the finish line at 9°27′ west longitude, where we first headed east. We clasp hands and give each other a hug. We have achieved the craziest of our crazy dreams, the first nonstop flight around the world in a balloon. In Geneva our control center team is flooded in champagne in front of cameras from all over the world. But for us nothing has changed. We are above the same desert we left from, and we have yet to find a suitable place to land. The fuel has held out, so, for the thrill of it as much as for a less remote landing, we fly another 2,380 miles, at speeds exceeding 130 miles an hour, reaching Egypt.

During the last night, I savor once more the intimate relationship we have established with our planet. Shivering in the pilot's seat, I have the feeling I have left the capsule to fly under the stars that have swallowed our balloon. I feel so privileged that I want to enjoy every second of this air world. During our three weeks of flight, protected by our high-tech cocoon, we have flown over millions of people suffering on this Earth, which we were looking at with such admiration. Why are we so lucky? At this moment it occurs to me that we could use the largest portion of the Budweiser Cup million-dollar prize to create a humanitarian foundation, the Winds of Hope, to promote respect for man and nature.

Very shortly after daybreak on March 21, after 19 days, 21 hours, and 47 minutes in the air, *Breitling Orbiter 3* will land in the Egyptian sand, Brian and I will be lifted away from the desert by helicopter, and we will immediately need to find words to satisfy the public's curiosity. But right now, muffled in my down jacket, I let the cold bite of the night remind me that I have not yet landed, that I am still living one of the most beautiful moments of my life. The only way I can make this instant last will be to share it with others. We have succeeded thanks to the winds of providence. May the winds of hope keep blowing around the world.

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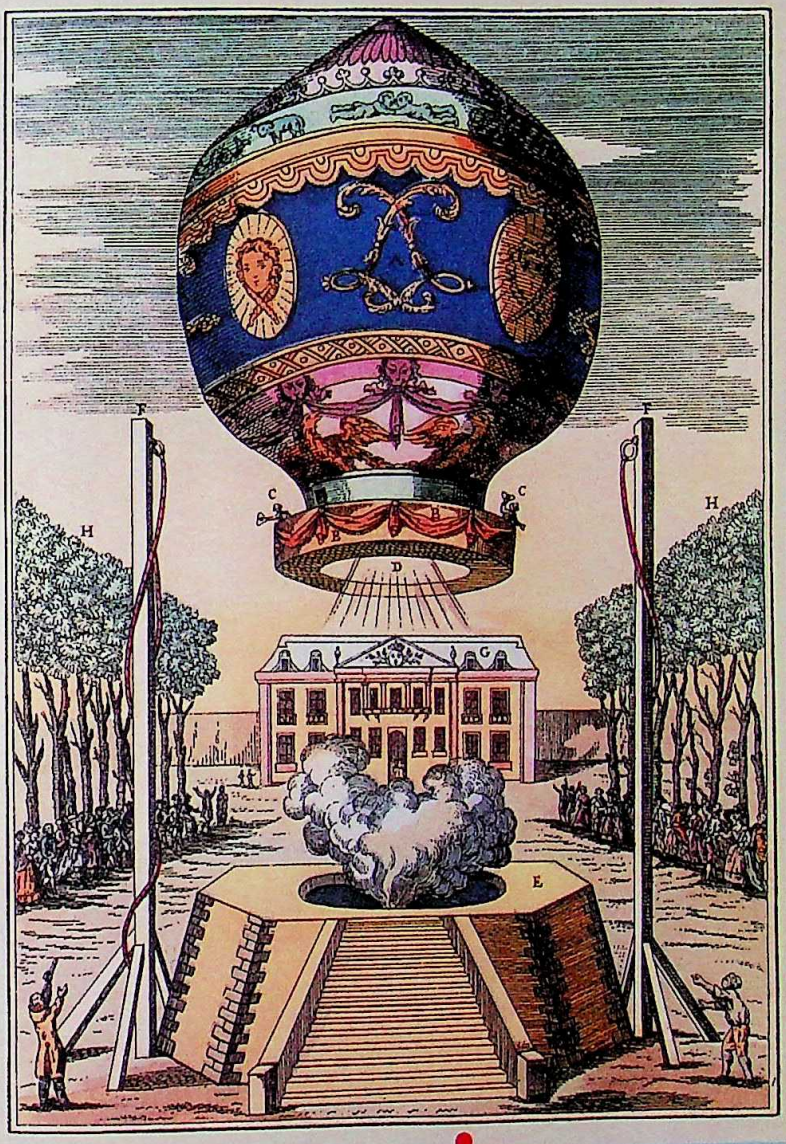
Ballooning



A History

More than two centuries ago balloonists became the first human beings to turn the dream of flight into reality. Yet this oldest form of flight is still in the experimental stage when it comes to long-distance adventures, many of which have been chronicled in the pages of National Geographic. *A review of ballooning breakthroughs is presented in the following pages.*

1783

Nov. 21: *First manned free flight*

To the delight of a crowd in a Paris garden, Jean-François Pilâtre de Rozier and François Laurent, Marquis d'Arlandes, become the first to fly an untethered balloon. Reaching a height of 3,000 feet, they soar over the city for about 25 minutes.

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THE ROMANCE OF BALLOONING, PATRICK STEPHENS LTD, 1971

André-Jacques Garnerin, Napoleon's balloonist, tested the firs

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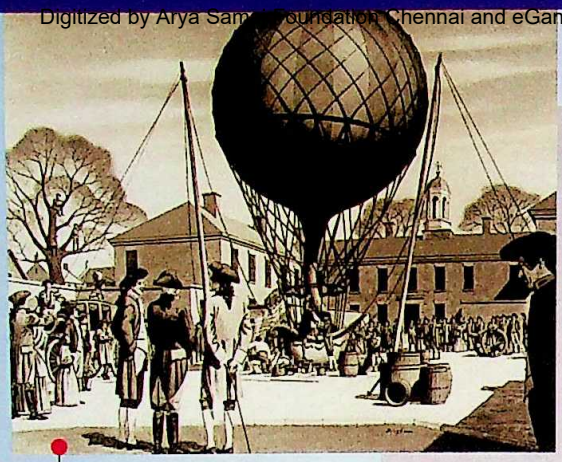

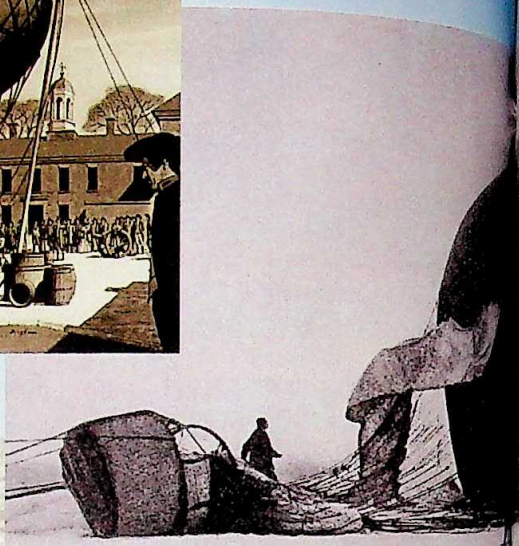

1784

June 4: *First flight by a woman*

Marie Elisabeth Thible, a French opera singer, becomes the first female aeronaut when she ascends in a Montgolfier balloon in Lyon, France. Posing as Minerva, goddess of wisdom, for this illustration, she points to a balloon in the clouds, while holding an image of King Gustav III of Sweden, who witnessed her flight.

1793

Jan. 9: *First free flight in America*

Gathered near what is now Independence Square in Philadelphia, spectators—including President George Washington—pay five dollars a ticket to watch the first manned balloon launch in North America. French balloonist Jean-Pierre-François Blanchard sips wine and snacks on a biscuit as he sails over the Delaware River to land in a field in New Jersey.

1861

Sept. 24: *Balloons used in Civil War*

Balloonist Thaddeus Lowe proves the worth of the recently created civilian Balloon Corps when he rises a thousand feet above Arlington, Virginia, spots Confederate troops in Falls Church three miles away, and telegraphs their position to Union troops.

1897

July 11: *First aerial Arctic expedition*

Swedish scientist Salomon August Andrée and two companions set out from Spitsbergen for the North Pole. The balloonists' fate is a mystery until 1930, when seal hunters find the expedition's diaries, logs, and film.

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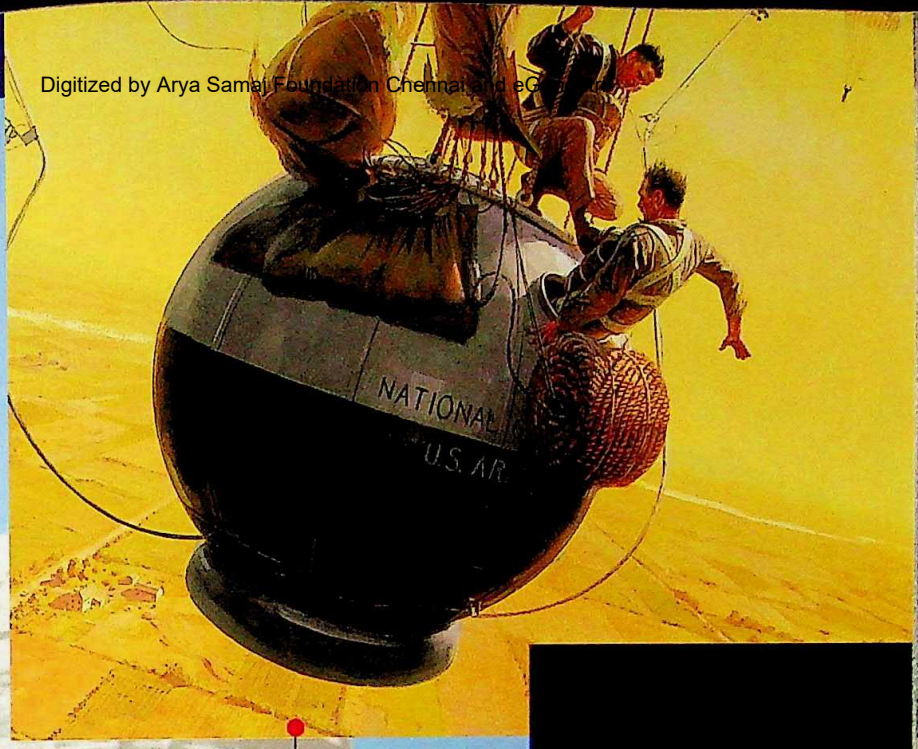

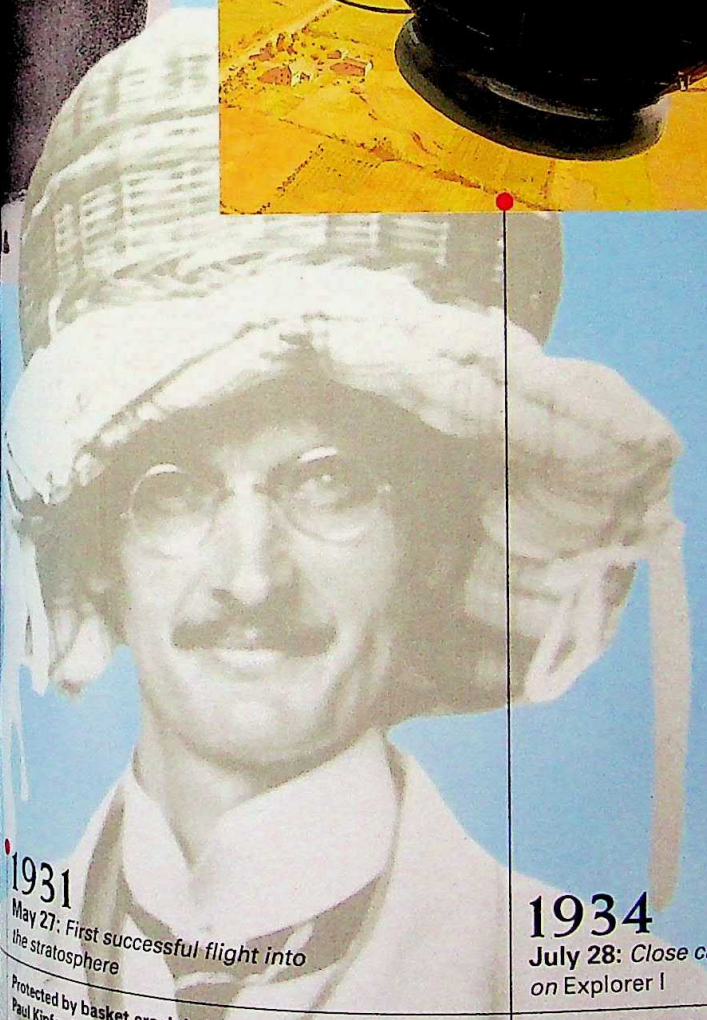

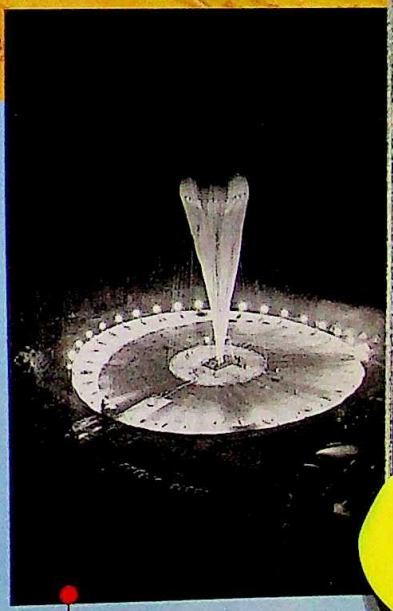

1931

May 27: *First successful flight into the stratosphere*

Protected by basket crash helmets that doubled as seats, Paul Kipfer, left, and Auguste Piccard become the first to reach the stratosphere in a pressurized cabin. On the morning of their launch from Augsburg, Germany, as they wait for workmen to release their balloon's ropes, Piccard and Kipfer are surprised to realize they are already aloft. "They had let us loose and forgotten to tell us anything about it," Piccard reports in the March 1933 NATIONAL GEOGRAPHIC. The two rise almost ten miles during their flight. "The sky is beautiful up there—almost black," Piccard writes. "It is bluish purple—a deep violet shade—ten times darker than on earth, but it still is not quite dark enough to see the stars."

1934

July 28: *Close call on* Explorer I

As the gondola of *Explorer I* plummets, Maj. William E. Kepner pushes Capt. Albert W. Stevens clear of the hatch, allowing both to parachute to the ground with Capt. Orvil A. Anderson, seen in the background of this painting for NATIONAL GEOGRAPHIC. Their balloon had ripped after reaching 60,613 feet, or 11 miles.

1935

Nov. 11: *New altitude record set*

Rising from the glowing Stratobowl in South Dakota's Black Hills, Stevens and Anderson brave the skies again in *Explorer II*, toting a ton of scientific instruments. Sponsored by the National Geographic Society and the U.S. Army Air Corps, the balloon rises to 72,395 feet, an altitude record held for 21 years.

CLOCKWISE FROM FAR LEFT: THE ROMANCE OF BALLOONING; THE BETTMANN; © ALBERT BONNIER AND HEARST ENTERPRISES; ART BY TOM CUNELL; RICHARD H. STEWART; AP/WORLD WIDE PHOTOS

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France's *Le Géant* ushered in an era of massive hot-air balloons in

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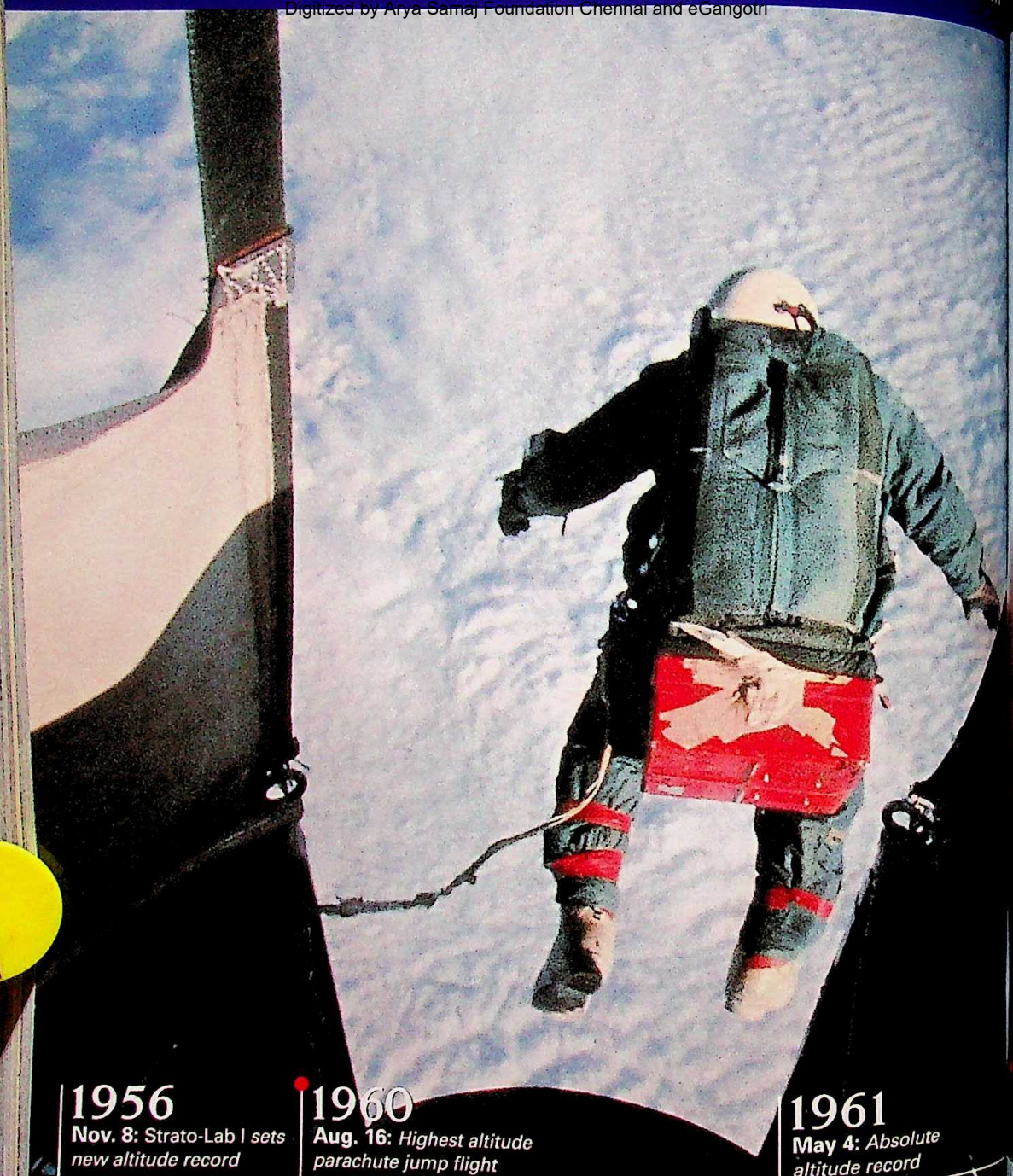

1956

Nov. 8: Strato-Lab I *sets new altitude record*

Lt. Comdrs. Malcolm D. Ross and M. Lee Lewis ascend to 76,000 feet in the U.S. Navy's *Strato-Lab I,* unofficially breaking *Explorer II's* record. Today the unheralded balloonists of projects like *Strato-Lab,* which pioneered flight on the edge of space, are remembered as "pre-astronauts."

1960

Aug. 16: *Highest altitude parachute jump flight*

Capt. Joe W. Kittinger rides a balloon to 102,800 feet before jumping from an open gondola to test a new kind of parachute. Rocketing downward for 13 minutes, he falls at more than 600 miles an hour, almost breaking the sound barrier with his body. He described his free fall for NATIONAL GEOGRAPHIC readers: "The big drop is the only way home. . . . At zero count I step into space. No wind whistles or billows my clothing. I have absolutely no sensation of the increasing speed with which I fall. I drop facing the clouds. Then I roll over on my back and find an eerie sight. The white balloon contrasts starkly with a sky as black as night."

1961

May 4: *Absolute altitude record*

Launching from a U.S. Navy ship in the Gulf of Mexico, Comdr. Malcolm Ross and Lt. Comdr. Victor Prather ascend to 113,740 feet in *Strato-Lab V,* setting a record that has stood for nearly four decades. After landing in the Gulf, Prather drowns when his pressure suit fills with water.

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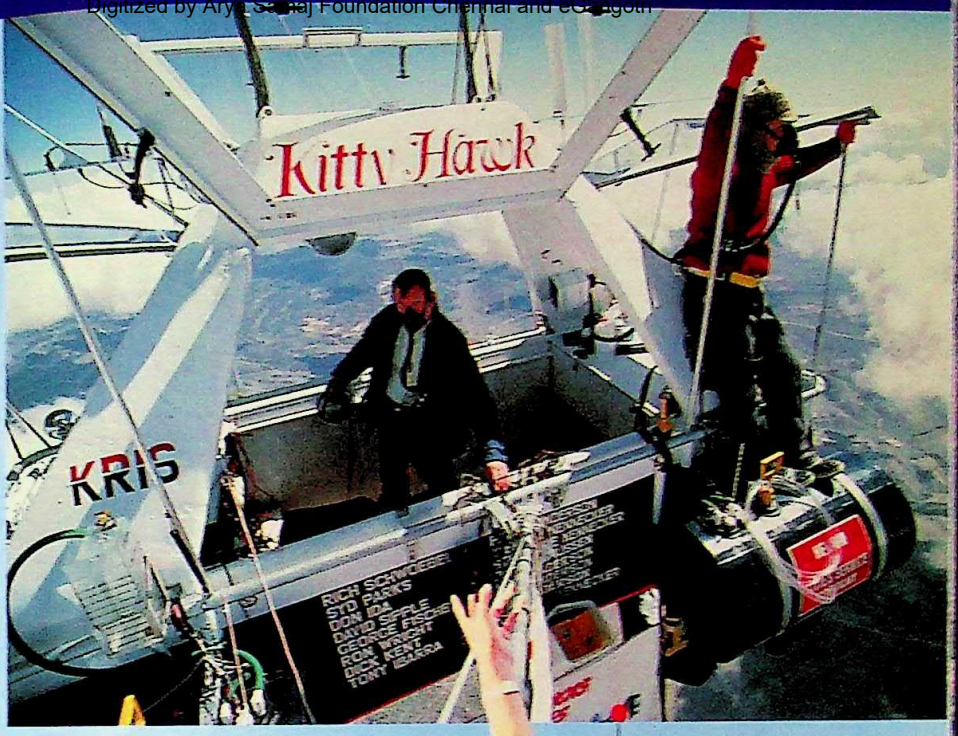
...3. Nearly 200 feet high, it had a two-story gondola with a balcony.



1978
Aug. 12-17: *First transatlantic flight*

Maxie Anderson, Ben Abruzzo, and Larry Newman (from left) become the first balloonists to cross the Atlantic Ocean. Their flight from Presque Isle, Maine, to Miserey, France, is smooth until a day before landing, when *Double Eagle II* suddenly drops 19,500 feet. Since Larry Newman had been in a balloon only once before, he fears the worst. A NATIONAL GEOGRAPHIC December 1978 story describes this moment of panic: "I was really upset, especially since we had been doing so well and seemed so close to success. I said to Ben and Maxie, 'You know, guys, I don't think we're going back up.'

'Yeah, we are,' they said.

I said, 'No, we're not. Tell you what. I'll bet you a hundred dollars we won't go back above 12,500.'

'Make it ten dollars,' said Maxie.

'Ten dollars—you're crazy! Let's make it a hundred.'

Sure enough, the balloon finally bottomed out . . . and about thirty minutes later we passed 12,500 feet. I couldn't have been happier. I just threw the hundred dollars at them."

1980
May 8-12: *First trans-continental flight*

Maxie Anderson and his 23-year-old son, Kristian, become the first to cross any continent by balloon. In *Kitty Hawk* (top) they begin their four-day flight from Fort Baker, California, enduring stiff winds and low temperatures to land safely in Quebec Province.

...MAXIE COLLECTION (OPPOSITE); MAXIE ANDERSON (TOP); MARC BULKA, GIPA

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A joint Soviet-French mission in 1985 dropped two unmanne

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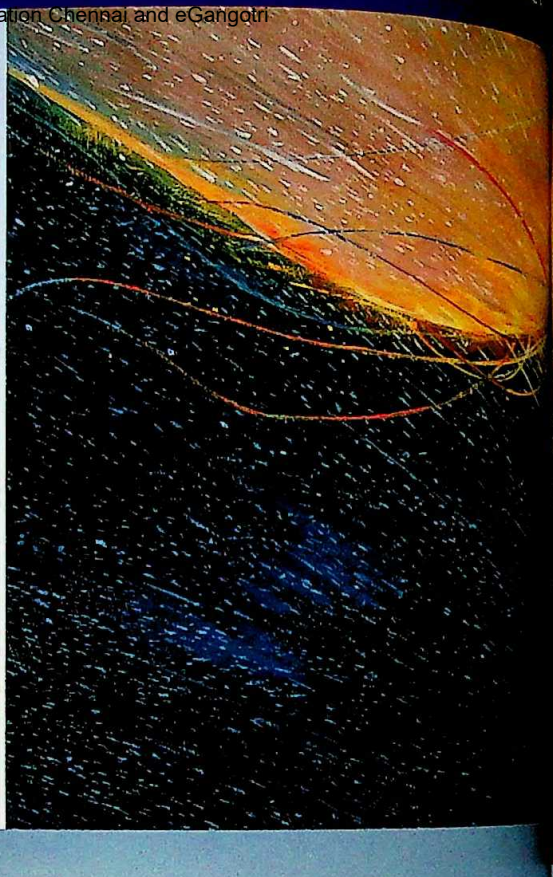

1981

Nov. 10-12: *First transpacific flight*

Halfway through the first balloon flight across the Pacific Ocean, Rocky Aoki, owner of Benihana restaurants, cooks a banquet on a propane stove for the rest of the crew of *Double Eagle V*—Ben Abruzzo, Larry Newman, and Ron Clark. The flight from Nagashima, Japan, to Covelo, California, lasts 84 hours and 31 minutes.

1984

Sept. 14-18: *First solo transatlantic flight*

Setting a record for the longest solo flight, Joe W. Kittinger crosses the Atlantic Ocean in *Rosie O'Grady*. Launching from Caribou, Maine, he flies to Savona, Italy, where he breaks his ankle in a crash landing.

1991

Jan. 15-17: *First hot-air Pacific crossing*

Richard Branson and Per Lindstrand set out across the Pacific Ocean in the 220-foot-high *Pacific Flyer*, the largest hot-air balloon ever flown. Their 46-hour flight breaks previous duration and distance records and proves that hot-air balloons can travel safely at speeds as high as 245 miles an hour. In 1987 the pair were the first to navigate a hot-air balloon across the Atlantic.

1997

Jan. 14-20: *New endurance record*

Alone in his small capsule, Steve Fossett flies *Solo Spirit* from St. Louis, Missouri, to Sultanpur, India. Fossett also becomes the first to cross Africa by balloon, setting a distance record of 10,361 miles and a duration record of six days, two hours, 44 minutes.

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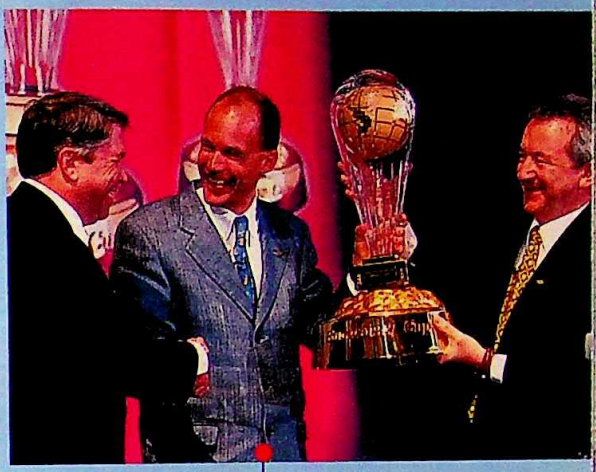
...lium balloons into the atmosphere of Venus to measure winds.



1998
Aug. 7-16: *New absolute distance record*

After a nearly flawless ten-day flight, having traveled 14,236 miles from Mendoza, Argentina, Steve Fossett's balloon *Solo Spirit 3* ruptures in a thunderstorm 500 miles off the east coast of Australia. "I'm going to die," he says out loud as he falls nearly 29,000 feet to the Coral Sea—flames from the burners melting the fabric of his deflating balloon (top). Knocked unconscious by the impact with the ocean, Fossett comes to in an upside-down capsule that is partly filled with water and partly on fire. As he pulls his life raft away from the capsule, propane fuel tanks explode. An emergency beacon helps rescuers find him the next day.

1999
Feb. 17-Mar. 7: *New endurance record*

Colin Prescot and Andy Elson grin from the hatch of their *Cable & Wireless* balloon before liftoff in southern Spain on February 17, 1999. Aloft for nearly 18 days, the two men set an endurance record but are forced by bad weather to ditch off the coast of Japan.

1999
Mar. 1-21: *Nonstop round-the-world flight*

Having surpassed all records for duration and distance on their 20-day flight around the world, Piccard and Jones accept the Budweiser Cup and a million-dollar prize, most of which will go to a charitable foundation.

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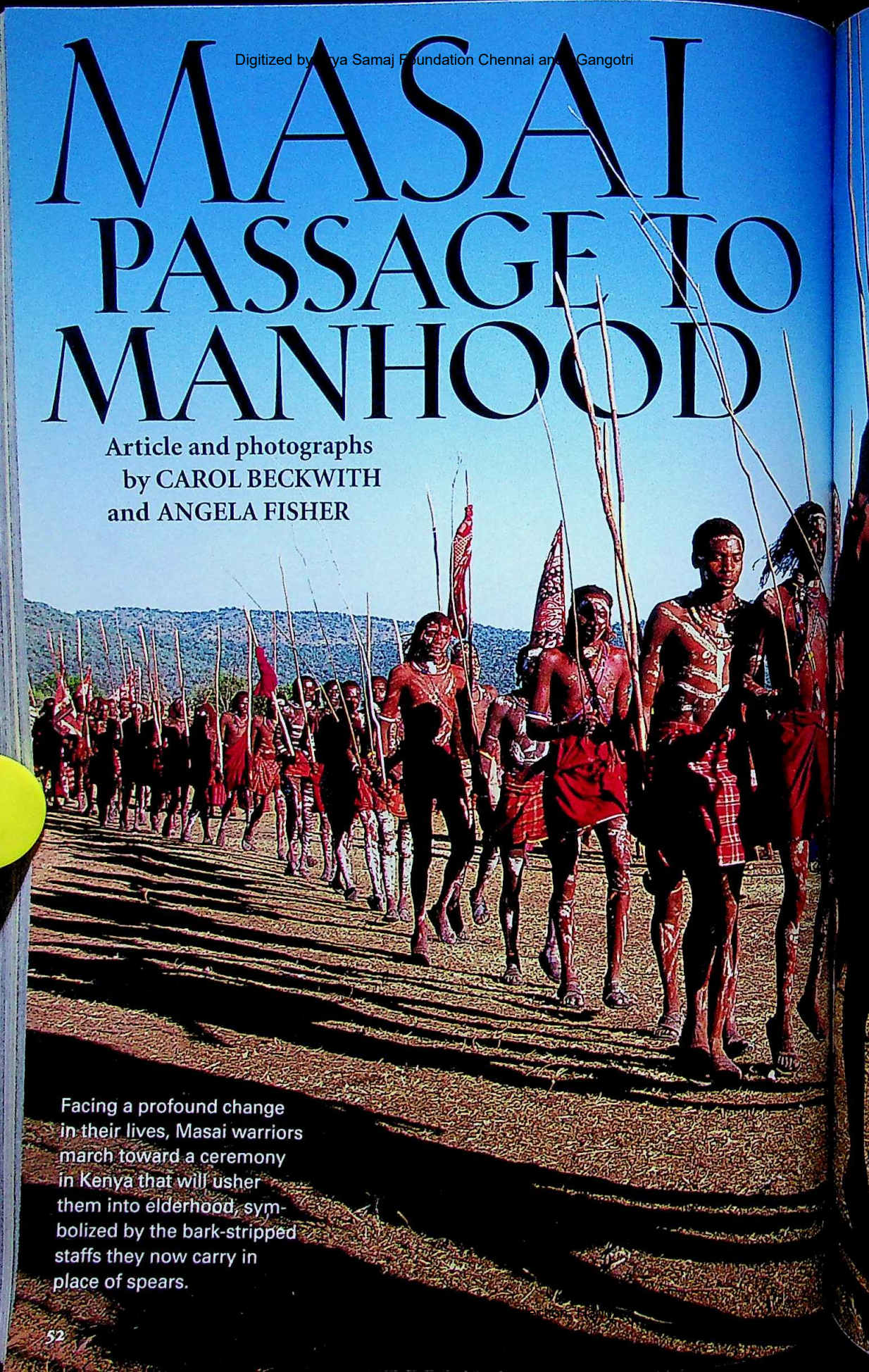
MASAI PASSAGE TO MANHOOD

Article and photographs
by CAROL BECKWITH
and ANGELA FISHER



Facing a profound change in their lives, Masai warriors march toward a ceremony in Kenya that will usher them into elderhood, symbolized by the bark-stripped staffs they now carry in place of spears.

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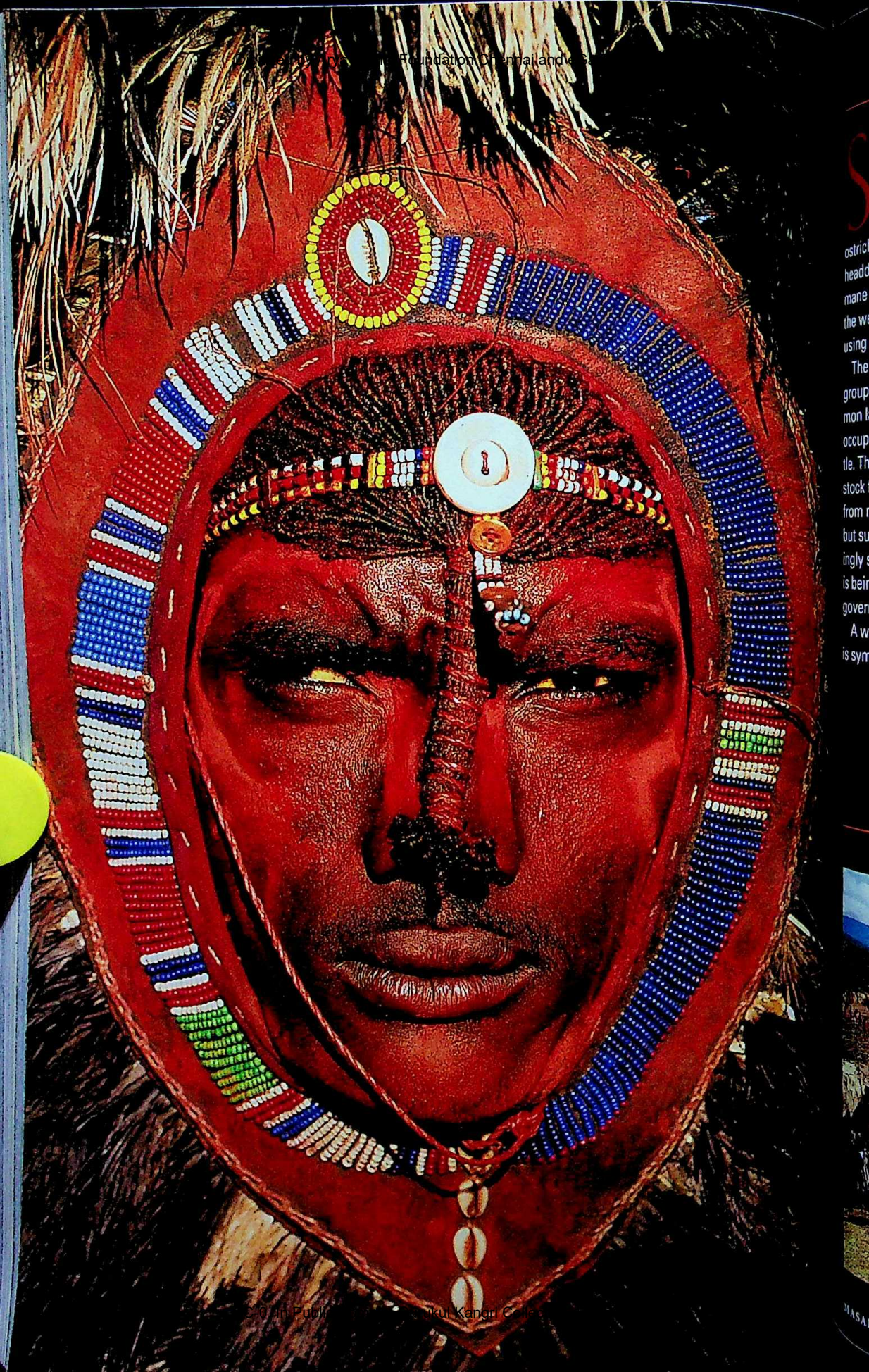

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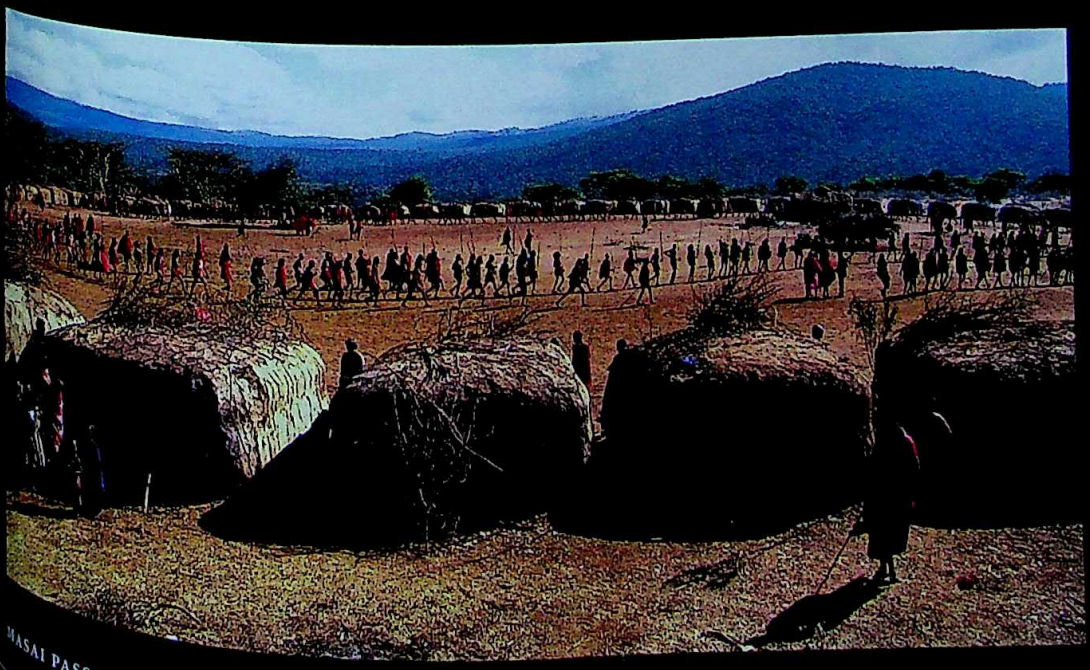
Stern visage of a painted warrior is framed by a splendid headdress of ostrich feathers (left). A headdress made of a lion's mane (right) signifies that the wearer slew the lion using only a spear.

The dozen or so Masai groups, united by a common language, are mainly occupied with tending cattle. They occasionally raid stock from each other and from neighboring tribes, but such warring is increasingly seen as theft—and is being prosecuted in government courts.

A warrior's fiery nature is symbolized by the red ocher body paint worn during the four-day initiation ceremony called Eunoto. Eunoto ends the period of Masai warriorhood that begins after a circumcision ceremony for male youths, usually in their late teens.

On a sacred site near the Kenya-Tanzania border, warriors' mothers build the *manyatta*, a circle of huts made of cow dung and branches (below). More than a hundred men from three Masai groups walked for days to reach the site. When they return home, they will face the responsibilities of elderhood: marriage, raising children, and acquiring cattle.

THE EUNOTO CEREMONY HONORS THE HERITAGE OF THE MASAI AND REAFFIRMS THEIR SOLIDARITY AS A GREAT WARRIOR TRIBE.



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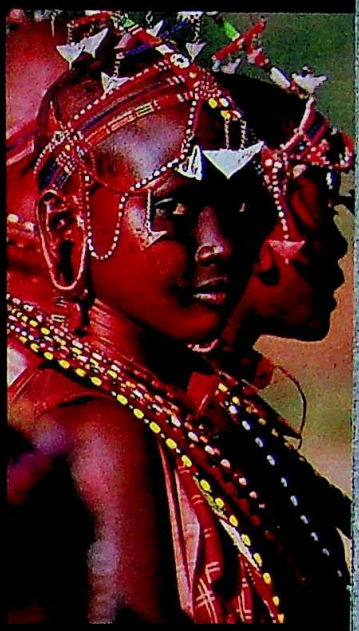
Following tradition, women cut the hide of an unblemished black bull into a continuous spiral (left) that will determine the size of the *osingira*, the ritual's most important building. On the second day initiates travel to a sacred chalk bank (below), where they paint their bodies with designs that may speak of their achievements, such as killing a lion or an enemy.

Young Masai girls (right) wear ornaments designed to sway as they dance. Before their Eunoto, warriors may have sex with these girls, who are prepubertal and uncircumcised. After initiation these relationships must end. As an elder, a man may marry a mature woman, circumcised at puberty, and may take more than one wife.

The Masai are a seminomadic people of about 300,000, whose land straddles the Kenya-Tanzania border. The future of such large-scale ceremonies is in doubt, as more Masai send their sons to school, and into another world.



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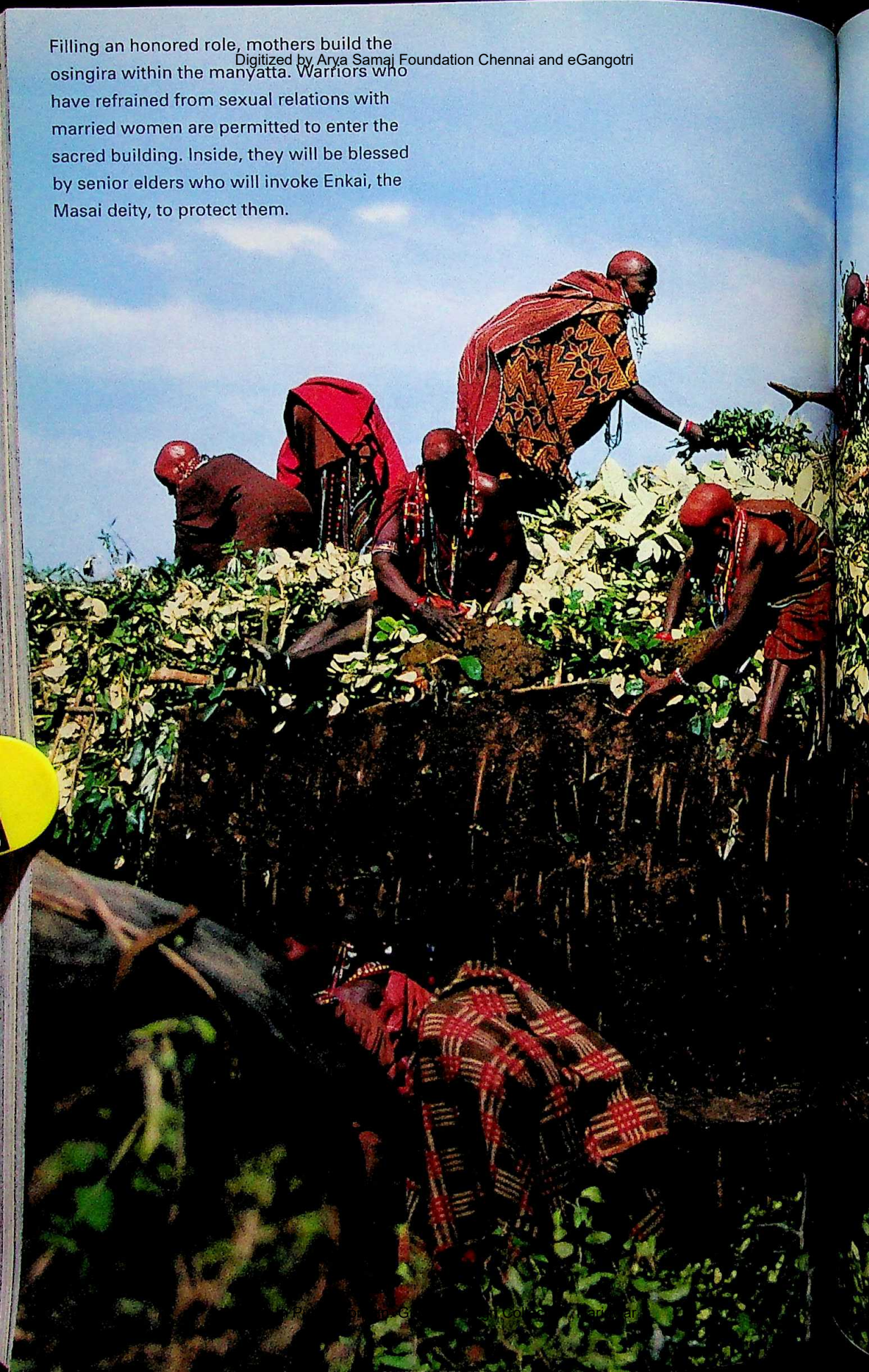
Filling an honored role, mothers build the osingira within the manyatta. Warriors who have refrained from sexual relations with married women are permitted to enter the sacred building. Inside, they will be blessed by senior elders who will invoke Enkai, the Masai deity, to protect them.



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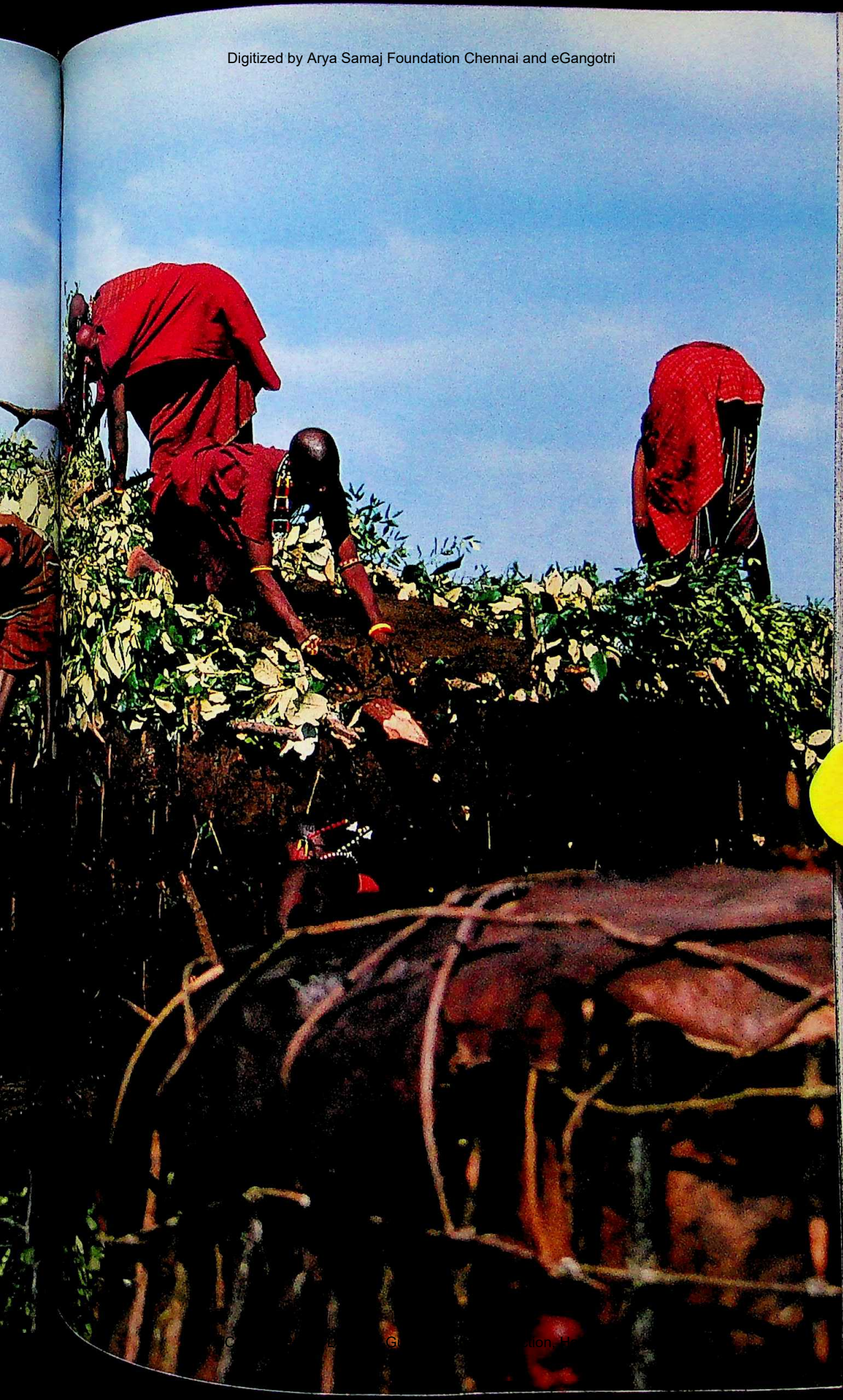

Sounding their horns and carrying shields made of Cape buffalo hide, warriors make the ritual run around the osingira accompanied by junior warriors, girlfriends, and mothers.

As the initiates circle the grounds with increasing speed, the import and emotion of the occasion sometimes lead to a contagious hysteria called *emboshona.* A warrior in a trance is helped along by the mothers (right). In an extreme case, another warrior is wrestled to the ground to keep him from injuring himself (left). Led to a quiet place and calmed, both rejoined the ceremony.

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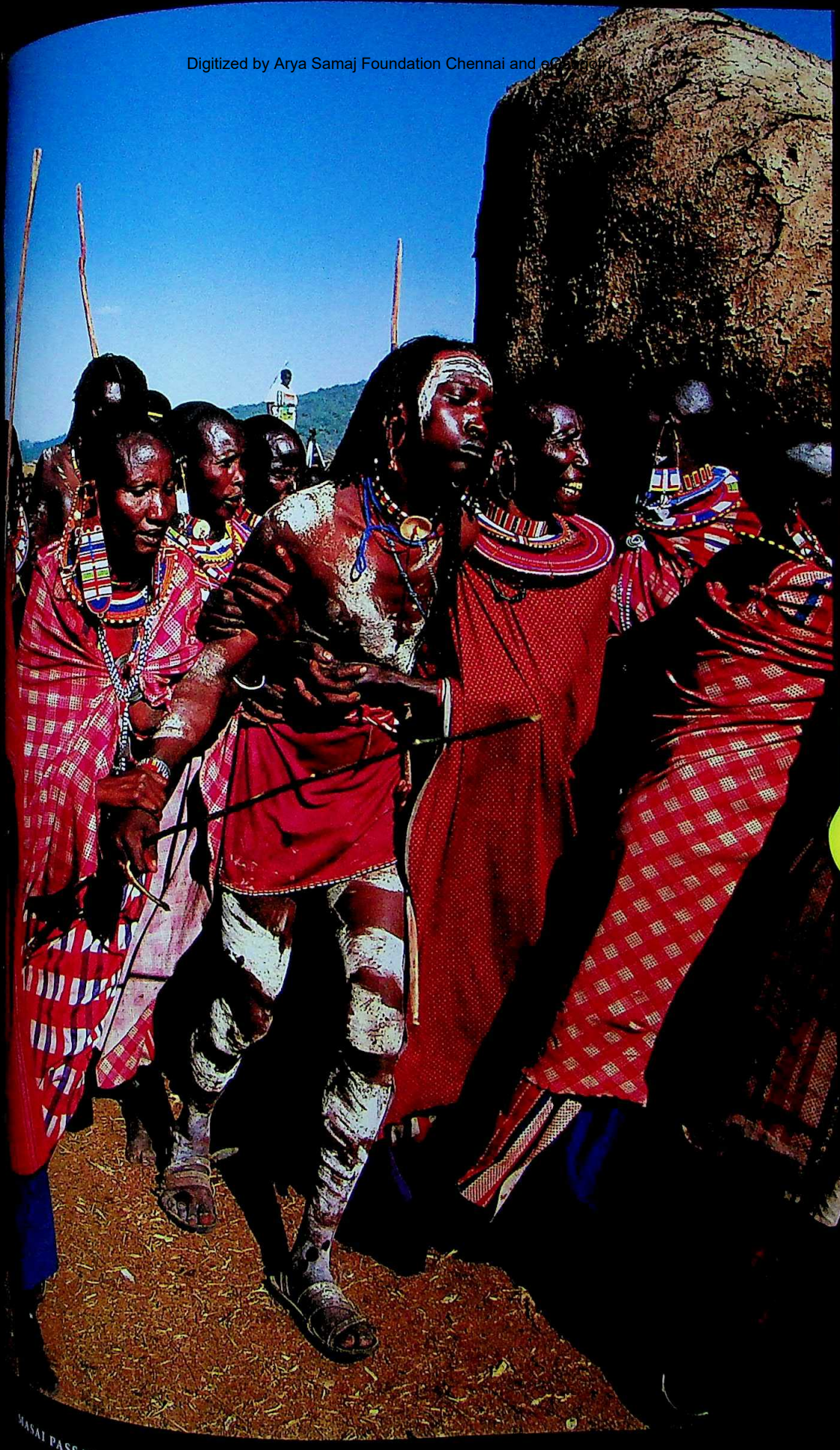

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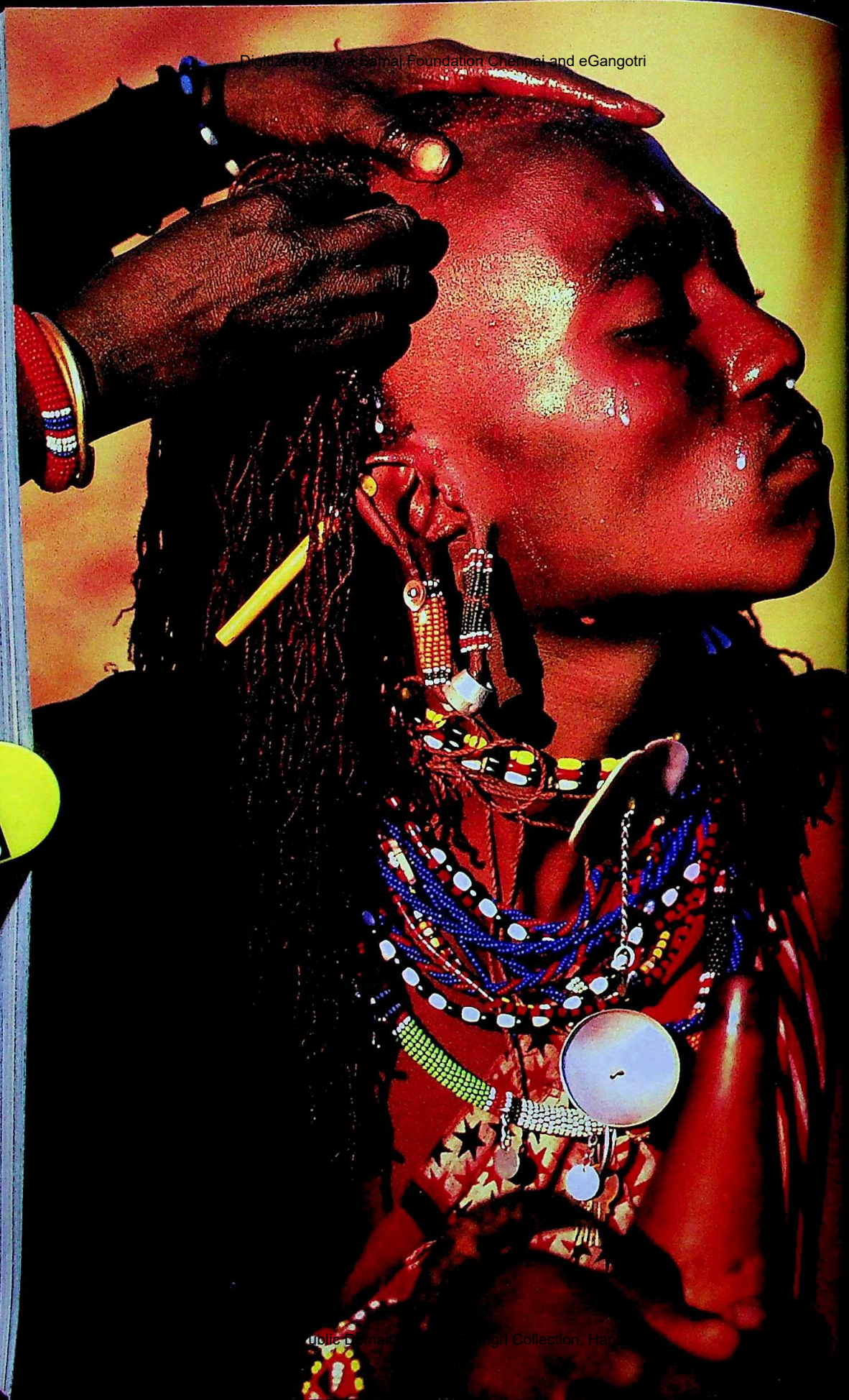

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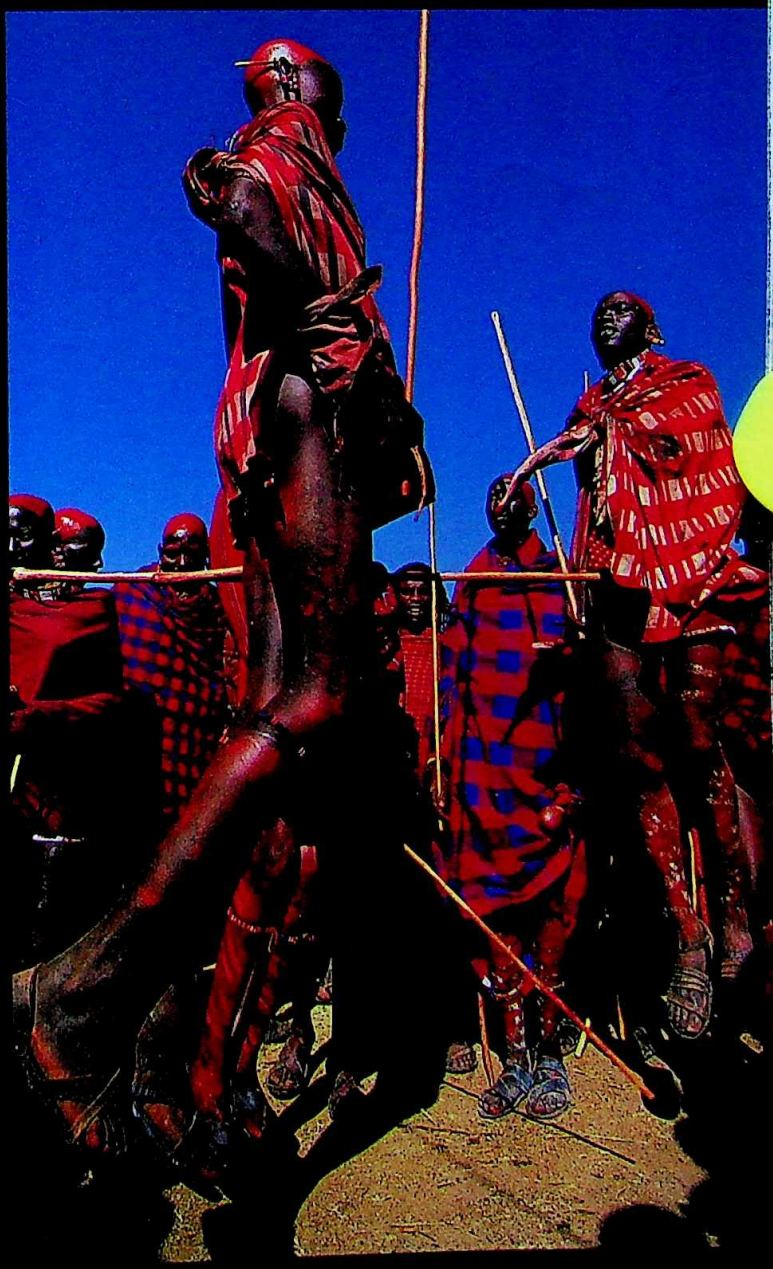
A MOTHER'S CEREMONIAL SHAVING OF HER SON'S HAIR IS A WATERSHED EVENT, MARKING THE END OF THE MATERNAL BOND THAT BEGAN AT HIS BIRTH.

The end of warriorhood is symbolized by the shaving of hair in the ceremony's most poignant moment. Using a balm of milk and water, each mother scrapes off the plaited locks of her son at sunrise on the final day of Eunoto.

The newly shaved men burst into an energetic dance to a song called *empatia*, demonstrating that though they've lost their warrior hair, they've not lost their vigor. At the height of each leap, the men shimmy their shoulders to the accompaniment of the rhythmic chanting of their fellow initiates.

CAROL BECKWITH and ANGELA FISHER include the Eunoto in their book *African Ceremonies*, to be published in October by Harry N. Abrams, Inc.



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Graduation day finds the new elders and a scattering of junior warriors gathered for final blessings. Senior elders walk among the initiates spraying them with mouthfuls of honey beer and milk for health and prosperity. Their words of advice: "Now that you are an elder, drop your weapons and use your head and wisdom instead." □

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Century-old ceramic urns store Italian olive oil, made at this Tuscan estate for nearly 1,200 years. Valued through the ages for food, fuel, salve, and sacrament, the olive's liquid gold remains unsurpassed among oils.

Olive Oil

ELIXIR OF THE GODS

BY ERLA ZWINGLE PHOTOGRAPHS BY IRA BLOCK

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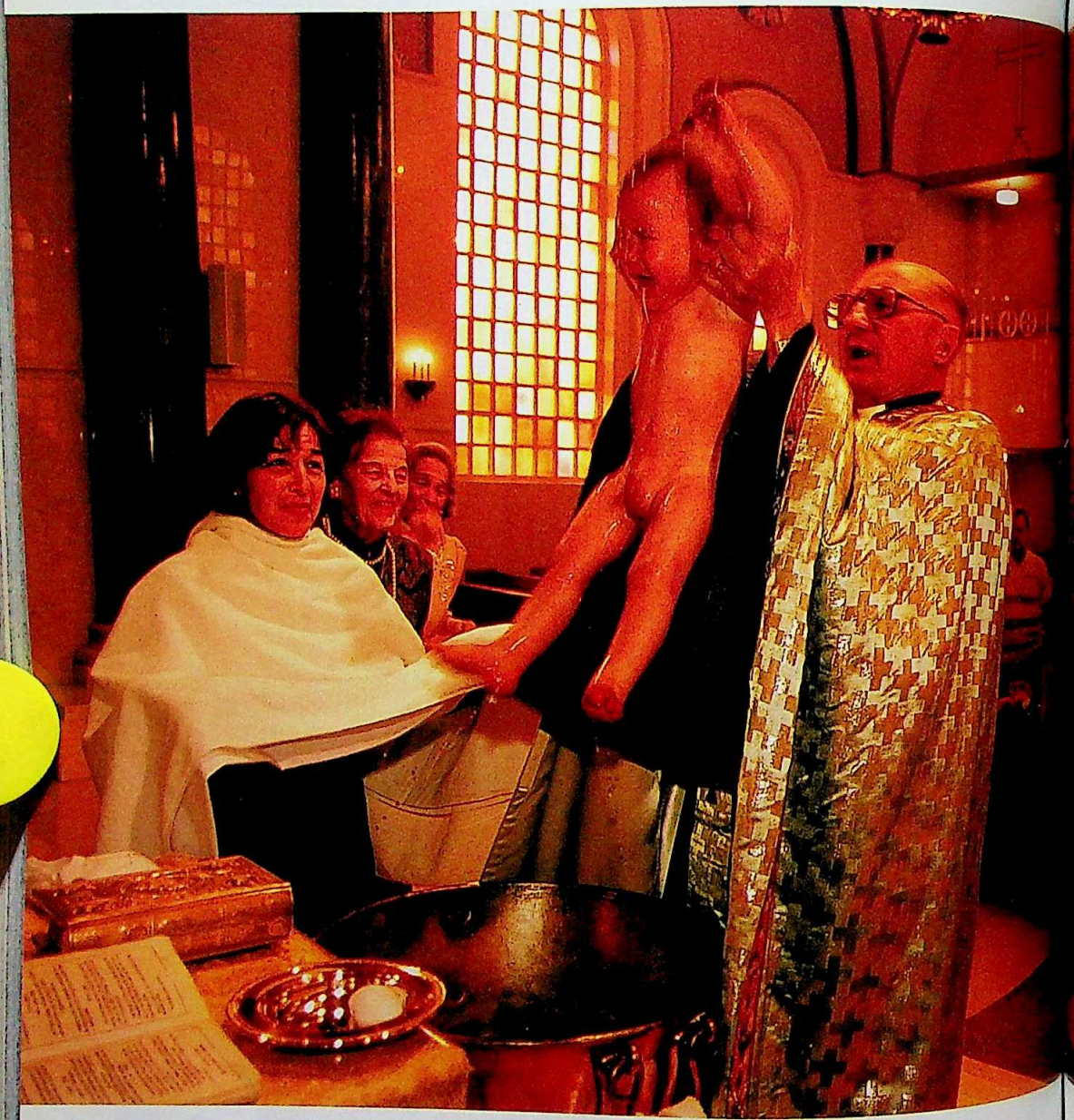

White linen and a godmother's warm embrace await ten-month-old Nicholas File at St. Sophia Greek Orthodox Cathedral in Washington, D.C., where anointing with olive oil and baptism in water signify salvation. "Oil enables the baby to slip away from the grasp of evil," says Father John Tavlarides. As for his own grasp? "I haven't lost one yet."

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UNTO ...E THROUGHOUT YOUR GENERATIONS.

—EXODUS 30:31

YOU CAN BURN IT, wash with it, lubricate squeaky hinges with it. Cosmetics are based on it, diamonds polished with it. Kings, babies, and the dying are anointed with it. It's loaded with vitamin E. It has no cholesterol. It's an amazing preservative, keeping fish, cheese, and even wine good for years. Boiled, it's one of the more ingenious weapons of war and torture. And, of course, you can eat it. For 4,000 years it has served the Mediterranean cultures as everything from money to medicine. Now the rest of the world is discovering olive oil, the most versatile fruit juice ever squeezed.

Until recently, for people beyond the Mediterranean olive oil retained an aura of the exotic; it was something eaten in odd ethnic dishes or lost on the specialty shelf in the grocery store somewhere between the kumquats and the saffron. Olive oil was usually first encountered in restaurants, where it unjustly acquired a reputation for being heavy, as it was often low quality and sometimes adulterated with anything from animal fat to glycerine.

But olive oil began gaining new respect after a study published in 1970 revealed that Mediterranean peoples have the lowest rate of heart disease among Western nations, a condition partly attributed to their liberal use of olive oil (it is rich in monounsaturated fat—the "good" fat—and also in antioxidants, which help prevent plaque buildup in the arteries). By the end of the eighties, olive oil had experienced an unprecedented boom in Western countries. This was apparently the result of a convergence of happy circumstances: Consumers were more interested in nutrition, more eager to choose natural products, and more willing to pay a higher price for a high-quality product. And as people discovered the appeal of numerous foreign foods, from shiitake mushrooms to Sumatran coffee, olive oil was bound to benefit. For the 1982-83 season the U.S. imported nearly ten million gallons of olive oil. In the 1997-98 season it imported almost five times that amount.

One frosty November morning I was balanced atop a ladder leaning against an olive tree in the Italian region of Tuscany. Sunlight slanted over the steep grassy hillside and folded itself among the olive trees and Chianti grapevines, gradually melting the shards of frost. A cloth was spread on the ground beneath me, and I was clawing at the branches with a yellow rakelike tool with seven curved tines. Olives were flying everywhere. Giuseppe Giotti, an olive farmer with ruddy cheeks and a massive black mustache, hovered anxiously below.

How you harvest olives depends on many factors—including the number of trees, the amount of money and time available, and the type of olive. Although the techniques vary, they're almost all strenuous, from stripping the olives by hand to beating the branches with long

ERLA ZWINGLE, a frequent contributor, became an olive oil devotee while working on this story. IRA BLOCK's most recent assignment for us was photographing a 67-million-year-old *Tyrannosaurus rex* fossil ("A Dinosaur Named Sue," June 1999).

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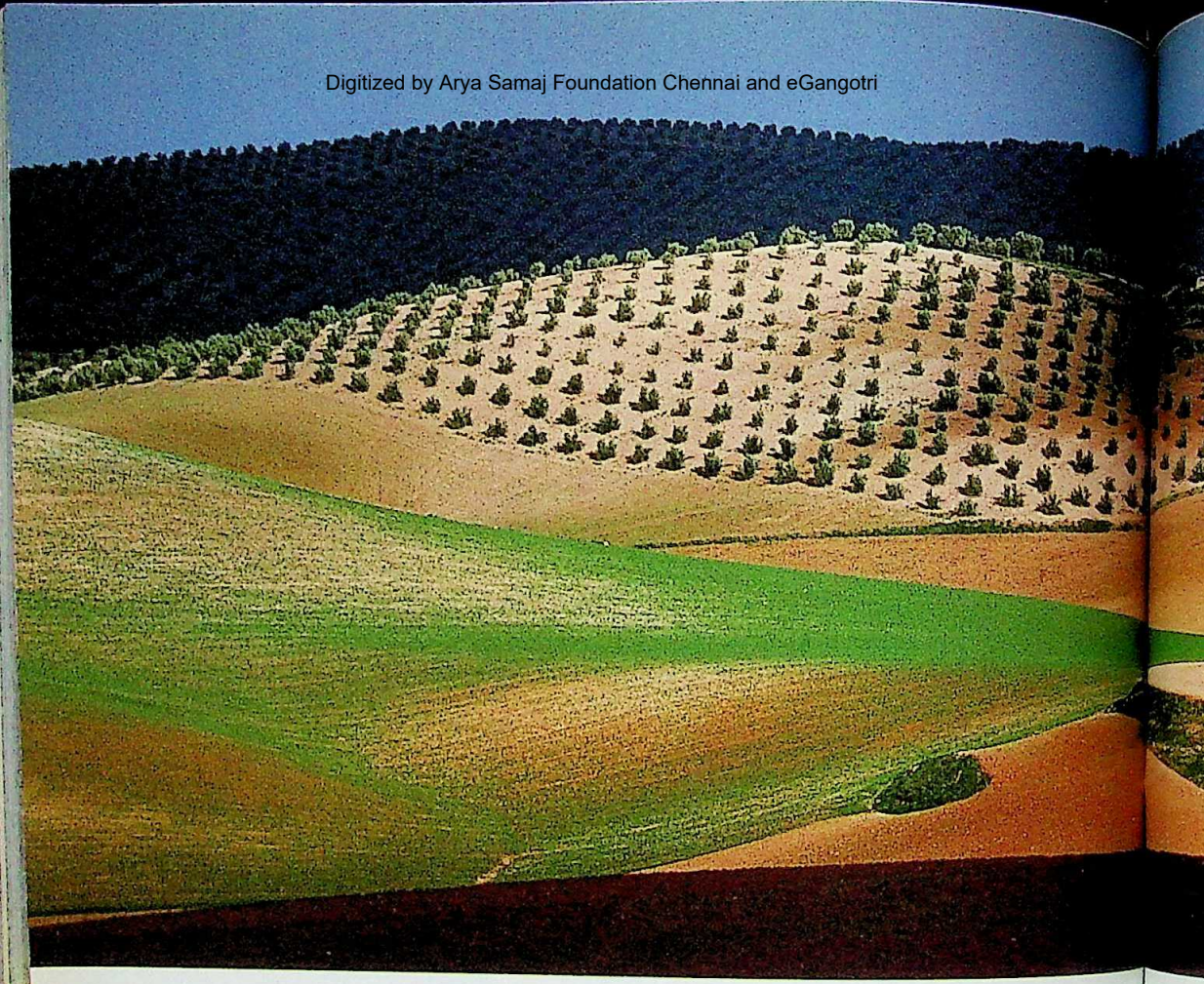

sticks. Giuseppe, like many olive farmers, doesn't own enough property to make it profitable to buy machinery (he has only 600 trees), and he doesn't make enough money from the oil to pay extra workers. His two sons have jobs, so the only people helping him today were Maria, his 73-year-old mother, and, temporarily, me. I was starting to sweat. The branches were springy and loaded with leaves, and the hard purple-green olives all seemed to be clustered inside. Behind every bottle of olive oil, I soon learned, is a troupe of tired people in old clothes.

After about 45 minutes I had removed all the olives I could find, plus a few that only Giuseppe could see. I climbed down the ladder, and we slowly gathered up the drop cloth, bouncing all the olives toward the center. We poured them clumsily into a large bucket. Olives fell into the grass and stuck to the soles of Giuseppe's boots.

Giuseppe's farm has been in the family for at least a hundred years. "I was in the Navy for 30 years," he said, "but when my father died, I came back." Now the future of the farm depends entirely on him.

With about half the harvest already done, he hoped to finish in another month or so. "If the rains don't start," he said. "The important thing is that it doesn't rain." Wet olives ferment faster inside their hundred-pound bags, and fermentation can ruin the oil's flavor. But he's looking forward to a substantial harvest. This year he'll pick more than two tons of olives, which should give him about a hundred gallons of oil.

Crowning a hillside 40 miles to the south is the abbey of the aptly

In uniform splendor legions of young olive trees swarm the hills of Andalusia in Spain, world leader in olive production. Thriving on heat and sun, gray-green olive groves have long inspired artistic souls. Wrote Renoir: "... the sky that plays across them is enough to drive you mad."

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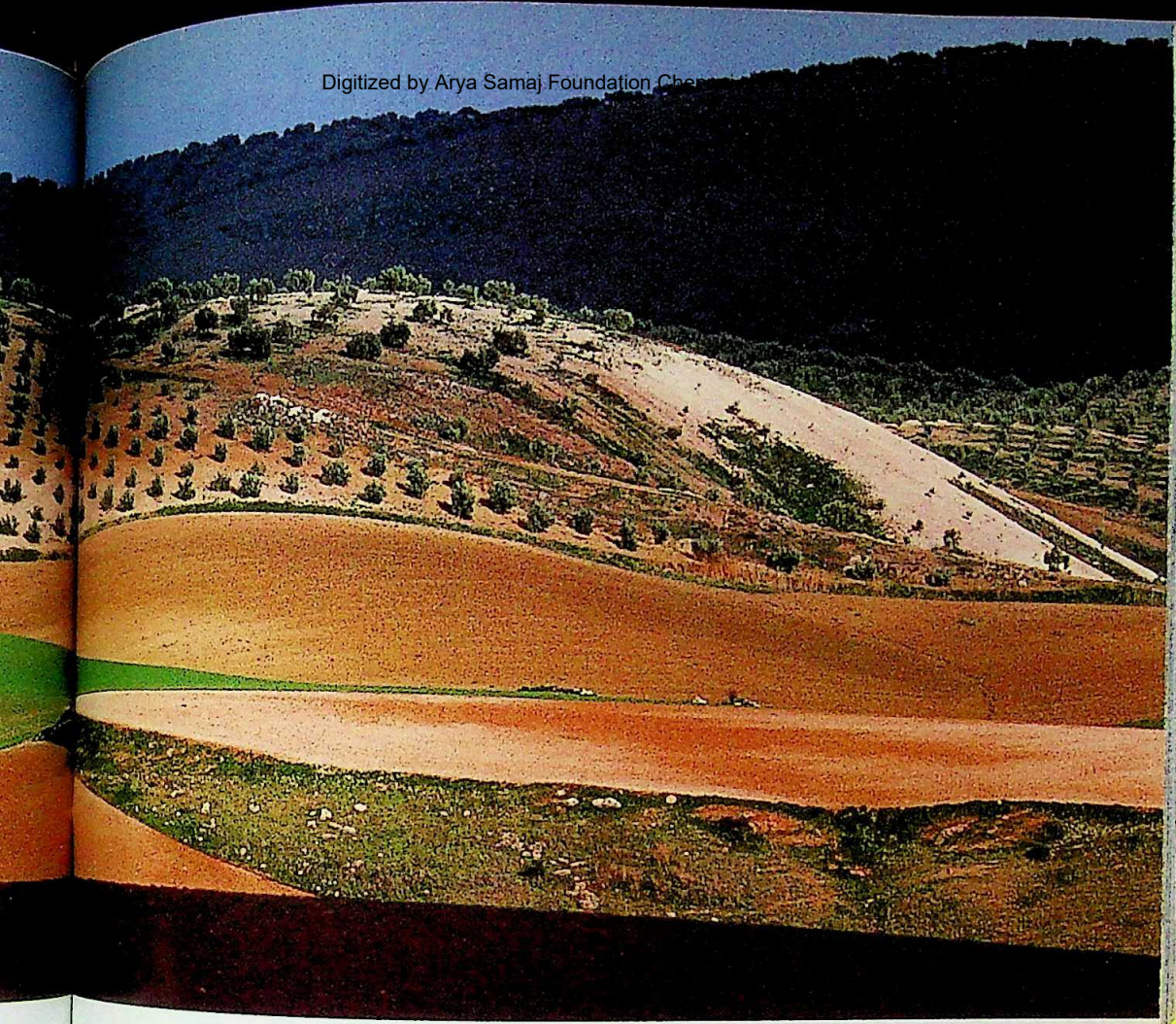
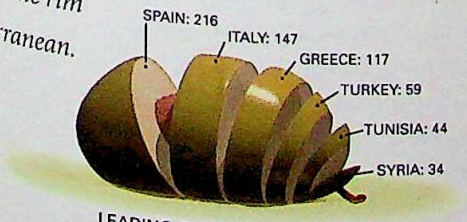


Olive pits dug from Levantine soils suggest that olive cultivation began in the eastern Mediterranean some 6,000 years ago. As it spread westward, olive oil became the ancient world's most valued commodity. Today 99 percent of all olive oil still spills from the rim of the Mediterranean.



LEADING OLIVE OIL PRODUCERS
(in millions of gallons annually)

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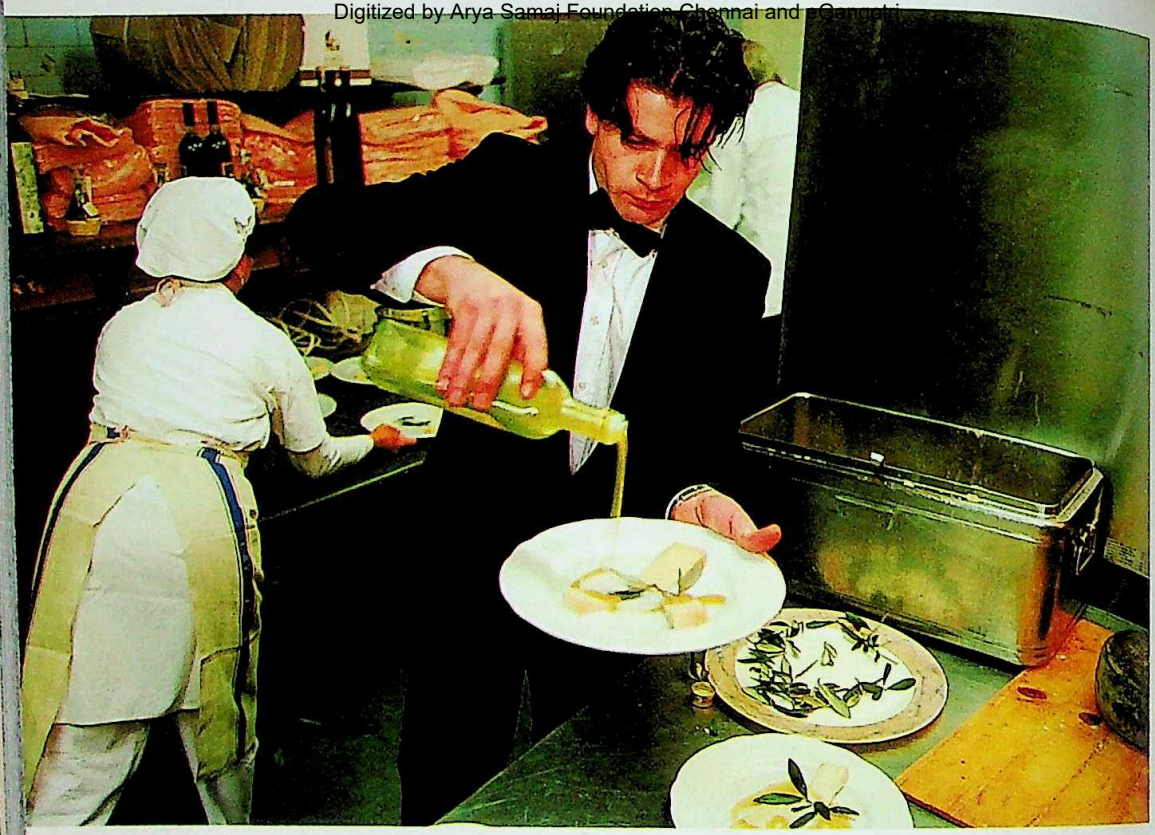

named Monte Oliveto Maggiore, Mount of the Olive Grove. Here Don Celso Bidin, one of 37 Benedictine brothers, oversees the monastery's olive mill, one of the few in Tuscany that still use traditional methods. Though milling techniques have been modernized, the simple process remains the same everywhere: Crush the whole olive, pit and all, separate the liquid from the solids, then separate the water from the oil.

Don Celso was a trim, robust figure in blue coveralls, with serious eyes but a cheerful expression. He showed me around the mill. Olives tumbled into a huge basin under two ponderous grindstones. (Animals once provided the power; now it's motors.) A roar filled the room as the stones crushed the olives, drowning the crooning of the doves in the cypresses outside. Workers spread the resulting dark brown paste on round, woven nylon mats and stacked them on a spindle. A metal plate was added, then the whole column of mats was squeezed by a hydraulic press at 400 atmospheres—the famous "pressing" of the oil. Water and oil slowly dripped from the mats and passed into a settling tank, where the oil rose to the top. Every week Don Celso bottled it by hand.

The work is painstaking and not as productive as more modern methods, such as using metal hammers to crush the olives and centrifuges to separate the oil. Still, no matter how many times I saw it, or with what technique, the process retained a miraculous aspect: at one end, trillions of bitter little nubbins and, at the other, elixir of the gods.

Don Celso cut thick slices of rough white bread and toasted them on a small electric grill. A rub of garlic, a sprinkle of salt, and a generous baptism of new oil. The flavor was rich, fruity, with a powerful afterbite of pepper, a prized quality of classic Tuscan oil. Bread with oil is the olive

A drizzle of peppery Tuscan oil and a sprig of olive leaves transform sheep cheese into savory art at a banquet in Siena. From sharp Tuscans to sweet Ligurians, Italy's olive oils are prized worldwide. "Italians treat oil as they would a valuable wine," says waiter Roberto Lachi. "To waste it feels like a sin."

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"Greek olives and olive oil are the best," says Konstantinos Kokkalis of Athens, whose unabashed bias typifies rival growers in the Mediterranean. Since its fabled birth as a gift from Athena, the olive tree has been revered by Greeks, who have the world's highest per capita use of olive oil. "The olive," says Kokkalis, "is blessed by God."

farmer's immemorial breakfast, and plenty of people still start the day this way. Some even skip the bread and drink a teaspoon straight.

"We also harvest in the traditional way," Don Celso told me in his warm baritone, "by hand or with combs. It would be less expensive to do it with machines, but it's more a social thing. Twenty people come to help with the harvest, and we pay them in oil."

I asked which was more important, oil or wine. "Certainly the greater awareness has been toward wine," he replied. "But in terms of history and sacredness oil has a deeper meaning." Oil is still used to consecrate altars and for baptism; the word "Christ" means "the anointed one."

The Mediterranean world has regarded the olive as sacred for thousands of years. The ancient Egyptians credited the goddess Isis with teaching mankind its cultivation and uses. The Greeks believed that Athena, goddess of wisdom, bestowed the olive on mankind, thereby winning a contest among the gods for presenting the most useful gift. The Bible is brimming with references to olive oil, from the parable of the wise and foolish virgins (oil as lamp fuel) to the story of the Good Samaritan (oil as unguent) to the Prophet Elisha's rescue of the destitute widow (oil as item of trade).

Farmers on the eastern shores of the Mediterranean domesticated the wild olive tree some 6,000 years ago and began extracting its oil about 2,000 years later. Phoenician voyagers spread olive cultivation to Greece and Spain, and the Greeks took it to Italy. Today 74 percent of the world's supply of olive oil comes from those three nations.

The Tuscan olive groves are romantic, woven into scenery from a Renaissance tapestry: velvety green hills clad with vines and topped

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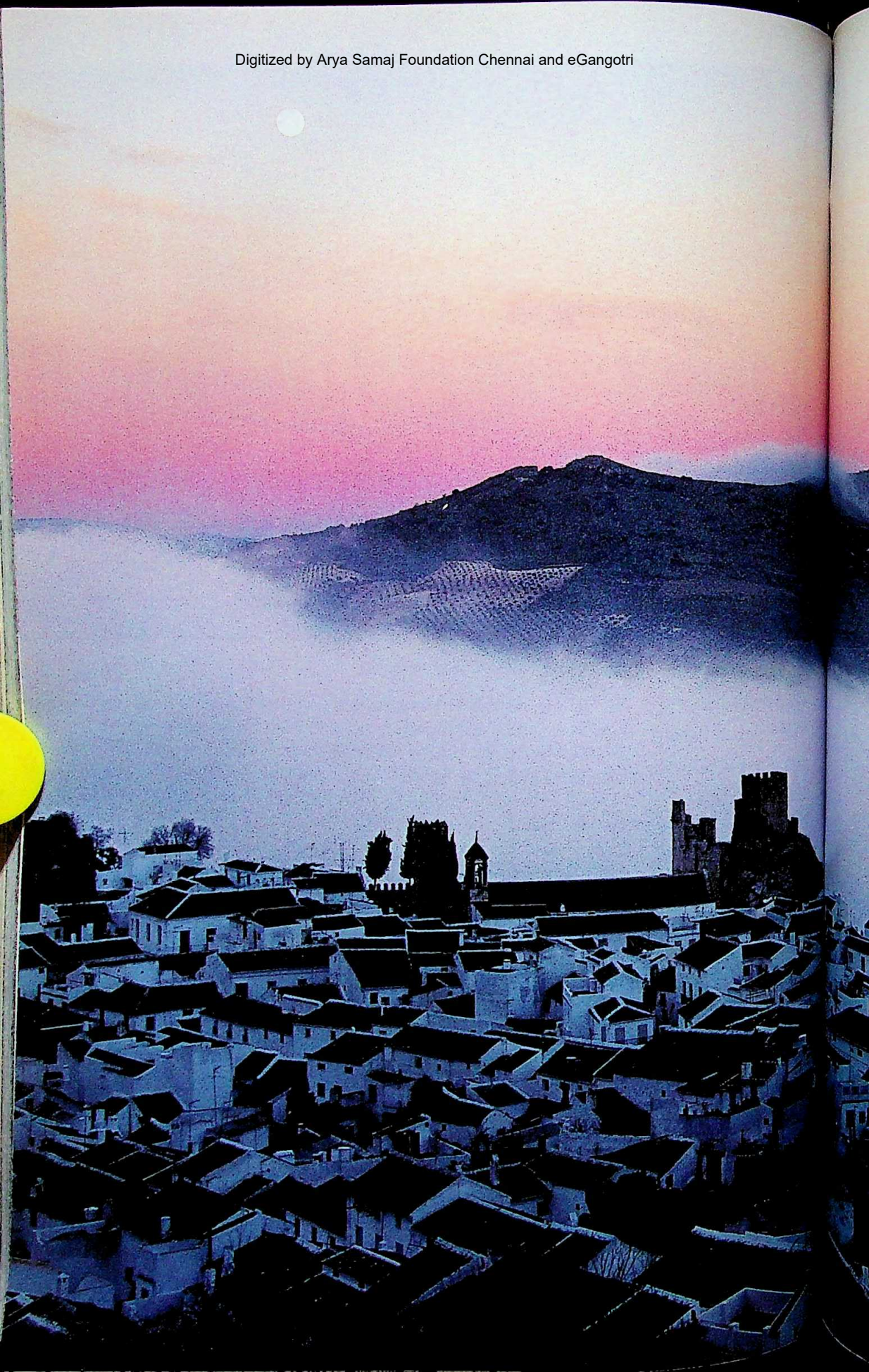

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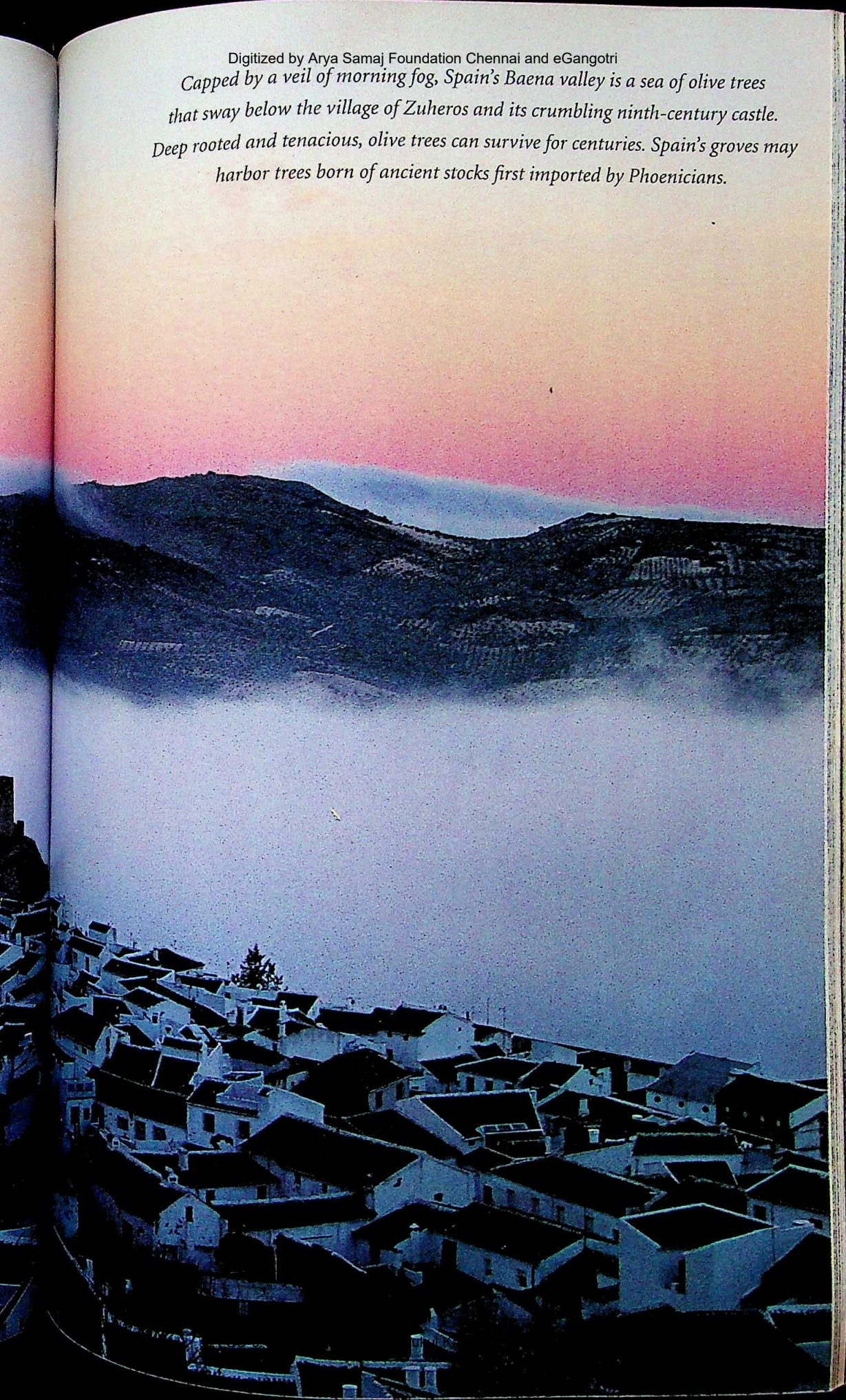
Capped by a veil of morning fog, Spain's Baena valley is a sea of olive trees that sway below the village of Zuheros and its crumbling ninth-century castle. Deep rooted and tenacious, olive trees can survive for centuries. Spain's groves may harbor trees born of ancient stocks first imported by Phoenicians.



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The practiced hands of Paco Núñez de Prado lay out freshly washed mats of esparto grass at his oil mill in Baena, Spain. He crushes his organically grown olives right after picking, then spreads the paste on mats, which are stacked and pressed to extract oil. Says the seventh-generation grower, "We're mixing culture and agriculture to make something perfect."

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ITY IS OBJECTIVE AND LIES IN THE SHADOWS.

—OLIVE GROWER PACO NÚÑEZ DE PRADO

by castles, all softened by a golden haze. The landscape lacks only a knight on horseback and a desperate damsel. But in Spain, particularly the southernmost region of Andalusia, oil is big business. Andalusia alone produces 192 million gallons a year, nearly 90 percent of Spain's output. In two years, one expert predicts, Spain will produce half the world total of olive oil, and you can see why: Sturdy, squat trees march off to the horizon, endless ranks of silvery-green plants corrugating the soil. Although most landowners have relatively small holdings because of the subdivision of property over the generations, the aggregate tracts are vast. It doesn't come as a complete surprise that the International Olive Oil Council is based in Madrid.

Once again there was the roar of machinery, but now it was from the production lines at Aceites del Sur outside Seville, one of Spain's foremost oil bottlers. Juan Ramón Guillén, the president, was giving me a tour of his empire. Every day tanker trucks filled with olive oil roll up to the huge storage tanks outside; inside, bottles and cans of all sizes race down conveyor belts. Graying and dapper, Guillén has a metabolism calibrated to the rate of production—we fairly galloped through the plant, bounding from topic to topic.

In one room Guillén showed me shelves full of the company's products, in all brands, sizes, colors, and scripts. Aceites del Sur exports to 60 countries, blending and marketing the oils according to cultural preferences. The can of La Española for Spain showed a young lady seated demurely in a bucolic olive grove; on the can of La Española destined for the United Arab Emirates, the young lady had been tactfully removed. Al-Amir oil was in a simple, small green tin. "The king of Saudi Arabia gives this as a traditional gift to pilgrims to Mecca," Guillén explained. "In the Arab countries they eat oil and also use it as a hair tonic. In India they put it on their hair but don't eat it."

Into a small laboratory reeking of solvents. "This is where we analyze the oil," he said. "Everyone thinks that all olive oil is the same. But some is sweet, some is bitter." Oil is analyzed not only to establish acidity but also for blending purposes. "In America they like an oil very, very light that doesn't taste of anything," Guillén said. "In Mexico they like darker and spicier. In the Arab countries they want oil that's green and sweet. They eat a lot of bread, and they like to 'paint' the bread."

He offered me a series of small glasses of oil to taste. I took about a teaspoon's worth of each into my mouth and gave a quick series of short, sharp slurps; not very attractive, but this way the flavors suffuse the nose and palate. A professional taster can distinguish a hundred different flavors, from straw to apple, artichoke to wood, almond to flowers. I could only manage one or two. The Manzanilla was fruity and smooth. The Moroccan Picholine was soft and sweet. I wanted to try the Picual, but Guillén quickly said it was "only for blending a little bit for the Arabs." He kept trying to dissuade me from sampling it. I insisted. And I liked it—it was strong and a little bitter, with a powerful aroma of olive.

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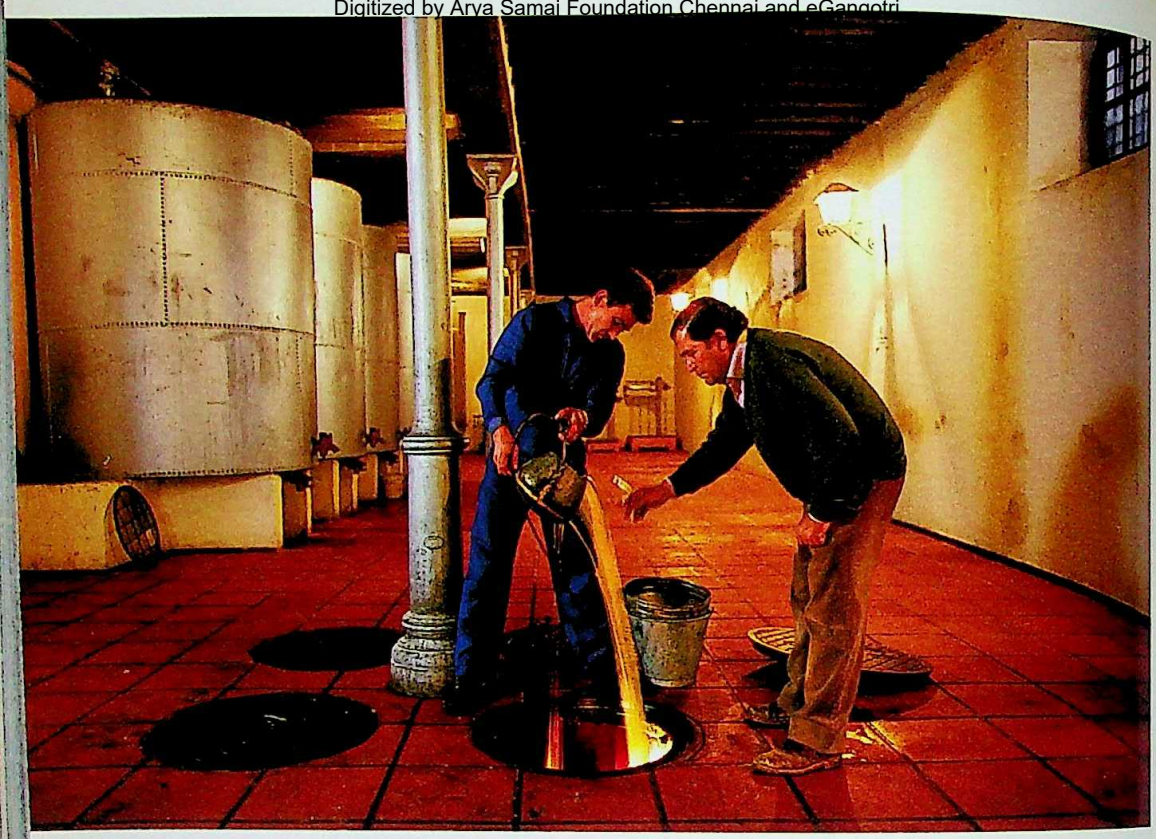

The best olive oil is extra virgin. To merit the term, which conveys that it has not been altered, the oil must result only from mechanical extraction without being heated, have less than one percent acidity, and meet a series of exacting standards for flavor and aroma—a judgment rendered by panels of professional tasters. The oils that fall short in either category are acceptable, though less interesting and slightly less nutritious than extra-virgin oil. They are marketed in several ways. There is "virgin olive oil," "refined olive oil," or simply "olive oil." These are essentially bland oils that may have been refined by a chemical process, with some amount of extra-virgin oil added to enhance the flavor and color.

Most big olive oil brands achieve a standard flavor that their customers like, then have to replicate it every year. The customer keen on extra-virgin oil knows there could be variations. But the typical shopper isn't looking for surprises. The only way the large companies can consistently produce an oil that matches their customers' expectations is to blend various oils according to their own recipe. However, not every country produces enough to satisfy both local and export demand—Italy foremost of all. Therefore that bottle of Italian oil may very well contain Greek or Spanish olive oil too, though recent changes in international trade standards now require exact labeling of the contents.

Still, the Greeks and Spanish are not entirely happy with this situation. Their oil deserves to be better known, they believe, but it is hidden in the shadow of the image of Italian oil. The Italians were first to capture the foreign market—73 percent of the European olive oil the U.S. imports comes from Italy—and they continue to dominate at least with

Checking the taste of his family's extra-virgin oil was a labor of love for the late Andrés Núñez de Prado of Baena, at right. To qualify as extra virgin, oils must meet exacting standards for pressing, acidity, and flavor. Natural hints of fruit, herbs, even bitterness can transform oil into nectar worthy of a toast.

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To your health! At Casa Benigna in Madrid, Rafael and María Alcalá make liberal use of olive oil. Its monounsaturated fats and antioxidants benefit the body—a welcome but secondary perk for María. "A meal without olive oil," she says, "would be a bore."

their reputation for high-quality oil. The others chafe. "You know what we say?" a Greek asked me. "Italian oil is like water." Said a Spaniard, "They import our oil to make theirs better." An Italian snorted, "The Spanish know nothing about olive oil."

Until recently Spain was content to sell in bulk to foreign blenders. But in Greece, which is awash in first-class oil, the many small producers accuse the Greek bureaucracy and a sort of mafia of middlemen of preventing them from bottling and marketing their oil as their own.

"So," one Greek farmer asked me, a little aggressively, "where do you think the best oil comes from?" I knew what I was supposed to answer, but I couldn't do it. "That's easy," I replied. "The best oil comes from the country with the most beautiful women."

But that was just a dodge. By that point I'd become a sort of olive oil junkie. Any oil I was eating was suddenly the best I'd ever had. I loved the peppery jolt of Italian oil from the Leccino or Correggiolo olives (great for frying foods). In Spain the Picual, Arbequina, or Hojiblanca varieties were full of character, yet also delicately aromatic (perfect on grilled fish). In Greece, the ubiquitous Koroneiki rendered an oil that was fruity and full of body (celestial on salad). I poured olive oil on everything: meat, vegetables, even cheese.

And I never tired of hearing what wonders olive oil could work. I read a study that demonstrated that foods fried in olive oil retain more nutritional value than those fried in other kinds of oil. Another study showed that women who eat olive oil more than once a day have a 45 percent reduced risk of developing breast cancer. It may have therapeutic effects on peptic ulcers and prevent the formation of gallstones. A Greek

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housewife said it makes the perfect hair conditioner (equal parts vinegar and oil) as well as the ideal burn treatment (mixed with lime and water). "My wife suffered from back pain," said a Cretan farmer. "Somebody told her to take two tablespoons of olive oil every morning on an empty stomach. She did this for ten days, and she was cured."

What could account for these amazing properties? Gerónimo Díaz, a Spanish chemist, oil taster, and technical adviser in Málaga, was eager to tell me. My newfound enthusiasm was as nothing compared with the adoration he feels for olive oil. "The olive oil world is so beautiful you could be captured by it," he declared. Dark-haired, of average build, with a crisp white shirt and tailored suit, Díaz could be any sort of businessman. But olive oil is his vocation as much as his livelihood, and he has traveled to Tokyo, Sydney, and Taipei to promote the benefits of this seemingly simple fluid.

We sat by the beach in Málaga while fishermen grilled the fish we were about to eat. He filled pages with chemical formulas, excitedly explaining the arcana of the oil's composition. Up to 80 percent of olive oil is made up of monounsaturated fatty acids, which resist oxidation better than polyunsaturates and help keep HDL—"good" cholesterol—levels up and bad cholesterol (LDL) down. Only 4 to 12 percent of the fat content of olive oil is polyunsaturated fat, which when oxidized can lead to arterial lesions.

"But you know," Díaz said, "it's not only important to have low cholesterol thanks to monounsaturated fat. Two other components in olive oil are also very important—vitamin E and the polyphenols, which are synergistic. They prevent oxidation of fatty acids, which reduces the risk of arteriosclerosis and some forms of cancer."

He paused while I studied his impromptu diagrams. To me, they were runic scribbles. To him, they were practically poetry. "My wife tells me I'm the most uncultured man in the world," he said without apology, "because I don't talk about anything else. I don't read anything else because I think it's a waste of time. I'm a pessimist in my private life, but where olive oil is concerned, I'm an optimist. It's a passion."

IN THE GREEK CITY of Kalamata—best known for its briny black table olives but home to delectable extra-virgin oil too—Panayiotis Sardelas consumes his oil in another form. He is founder, manager, and, I suspect, also foreman, truck driver, and accountant of one of the few soap factories in the Peloponnese using olive oil. His workshop and warehouse are in a big cluttered shed on the airport road.

"I started 40 years ago," he said. "I had an olive mill, and people asked me to make soap, so I took the risk. There was an old woman working for me, and she taught me how to make it. I started with a hundred pounds, and after three or four years it was four tons."

He buys the sediment that settles from new oil and mixes it with caustic soda and soapstone. He boils it all for 12 hours in a tank with a conical bottom. When it begins to solidify, he removes the caustic soda, which has sunk to the bottom, and washes the mixture with salt water to remove any remaining traces.

"The old people know that this soap is better than chemical ones," he said. "It lasts longer than other soaps, and you can use it for everything. Cut it in chips and put it in your washing machine. Some doctors prefer this soap for washing their hands."

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Fall lures Tuscans outdoors to begin the olive harvest—a ritual as old as Mediterranean myth. Olive oil has massaged Olympians, anointed kings, perfumed pharaohs, and enriched ancient coffers. Its taste will remain forever infused with history.

I took a small but heavy chunk of the muddy beige soap. It had a mulchy, sensible-shoes sort of odor. I asked if he ever thought of adding perfume. "No, no." He looked perplexed. "If you want something pure, you wouldn't mix something in it." That night I tried it. It didn't lather much, but afterward my skin felt startlingly smooth.

The soap factory was an OSHA nightmare, full of detritus and bits of things held together by other things. The rusty three-ton tank was empty; Sardelas had already made his batch. But atop the cluttered worktable a clear, bright little flame was burning. A plain glass full of olive oil. A floating wick. He noticed my glance. "Oh," he said simply. "We pray here every morning for a good day."

Beyond the city, the stony, austere hills stretched to the sea. Small splotches of color—a flowering pink almond tree, a golden mimosa—softened the land's bony outlines. Dark clouds were spreading veils of rain across the mountains; no harvest tomorrow. The evening moved slowly up the hillsides. The darkness rose, filling the hollows. But the olive trees held out to the end. They tossed eagerly in the wind, full of brightness, full of oil, full of life. □

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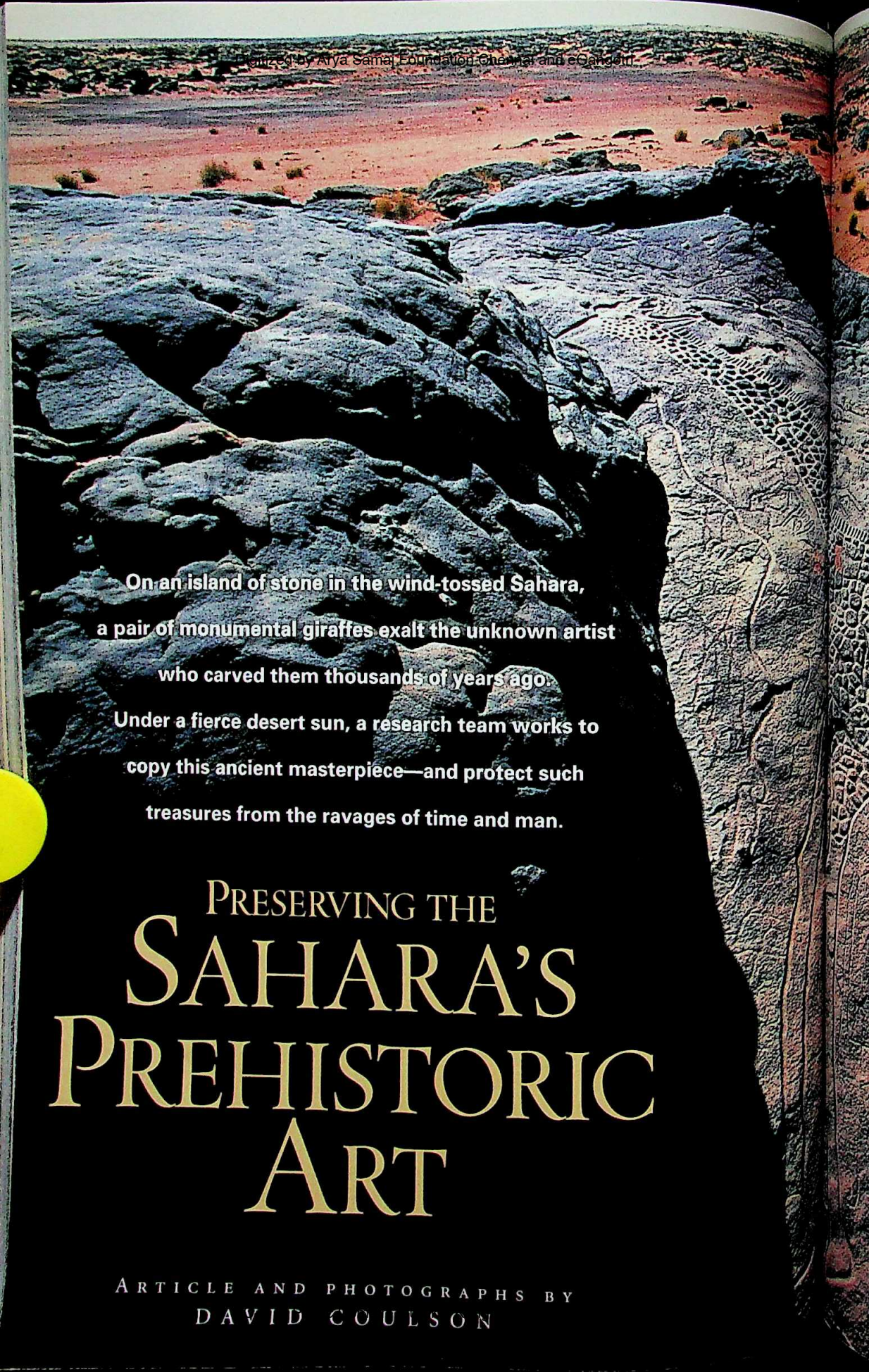

On an island of stone in the wind-tossed Sahara, a pair of monumental giraffes exalt the unknown artist who carved them thousands of years ago. Under a fierce desert sun, a research team works to copy this ancient masterpiece—and protect such treasures from the ravages of time and man.

PRESERVING THE SAHARA'S PREHISTORIC ART

ARTICLE AND PHOTOGRAPHS BY
DAVID COULSON

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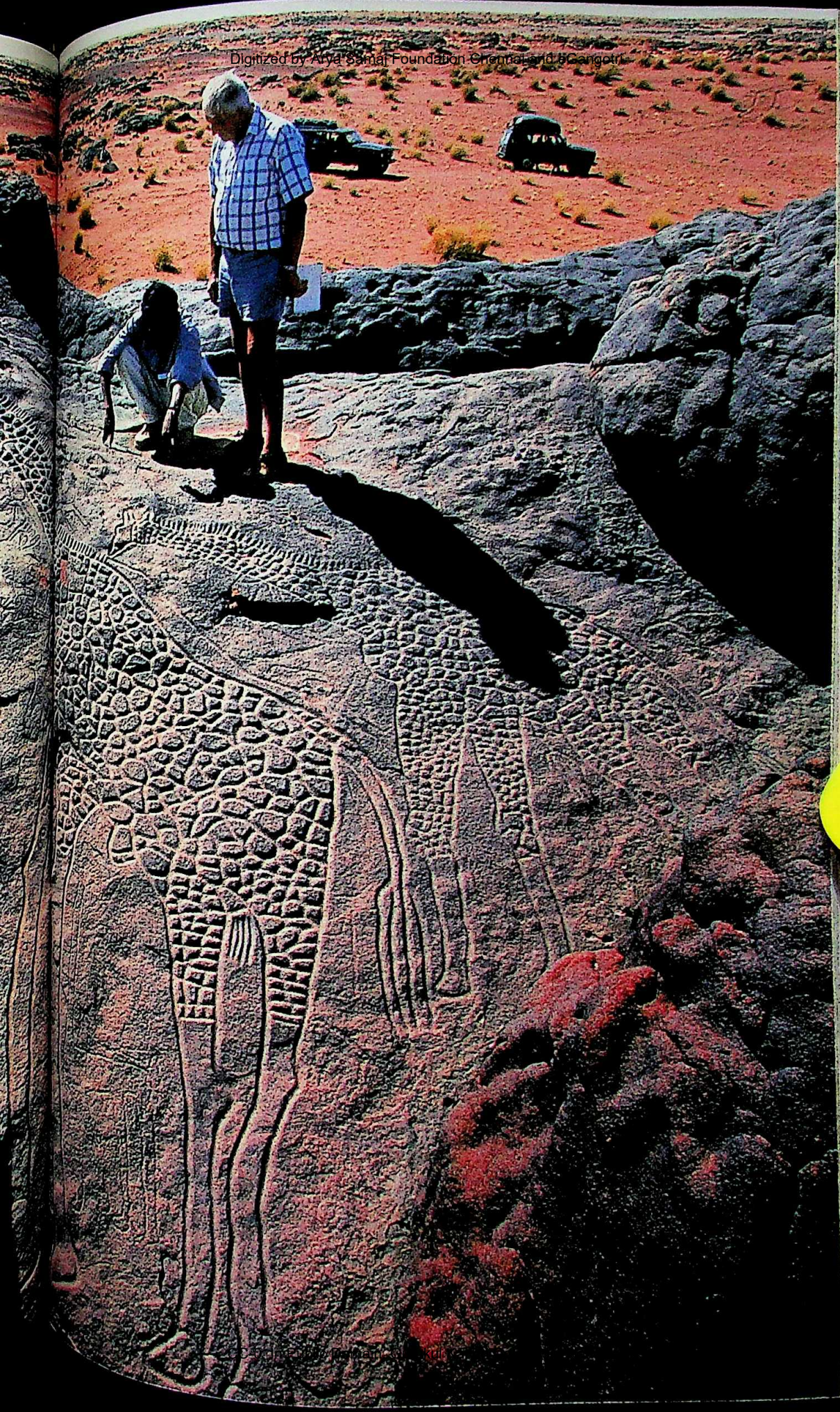

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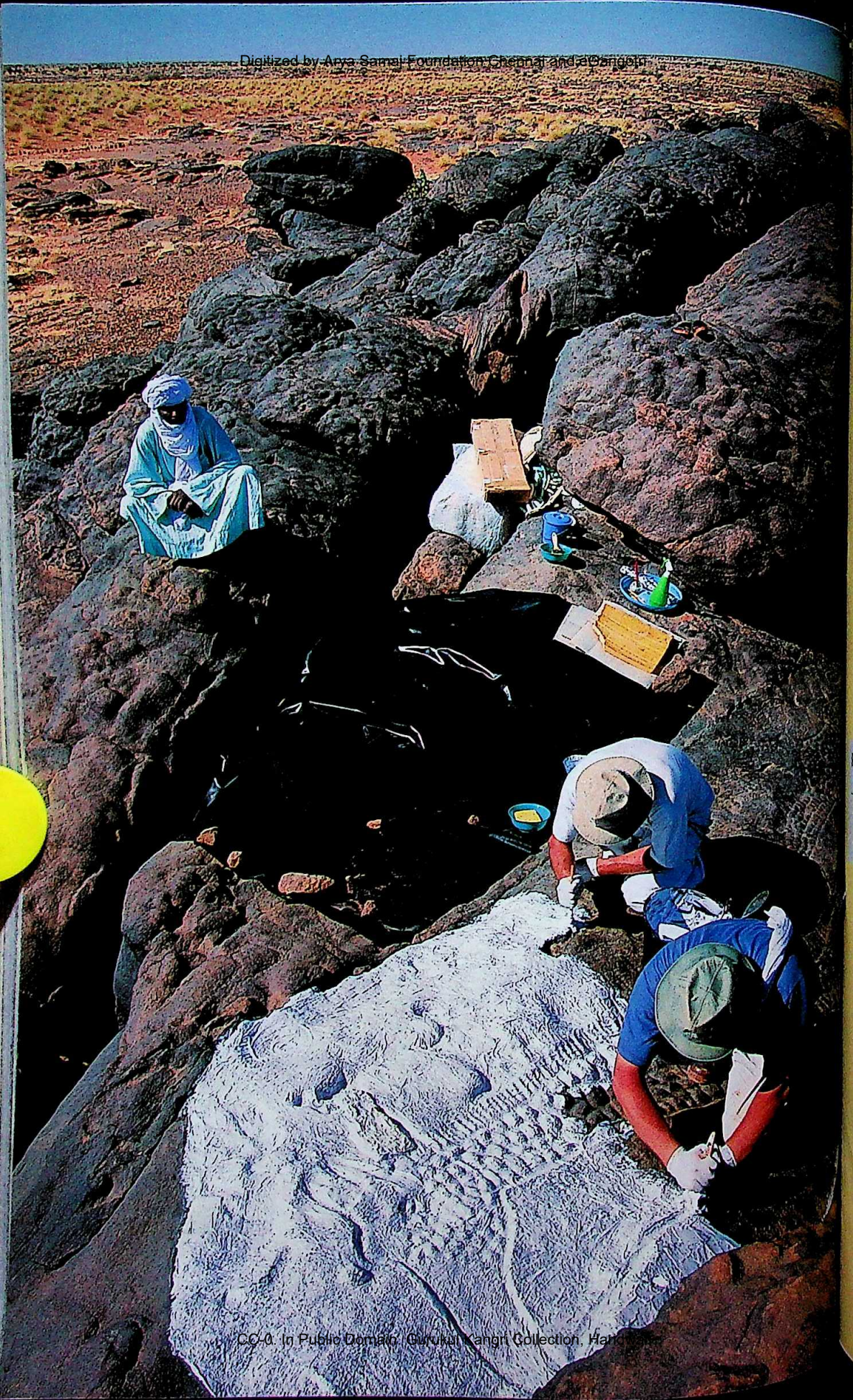

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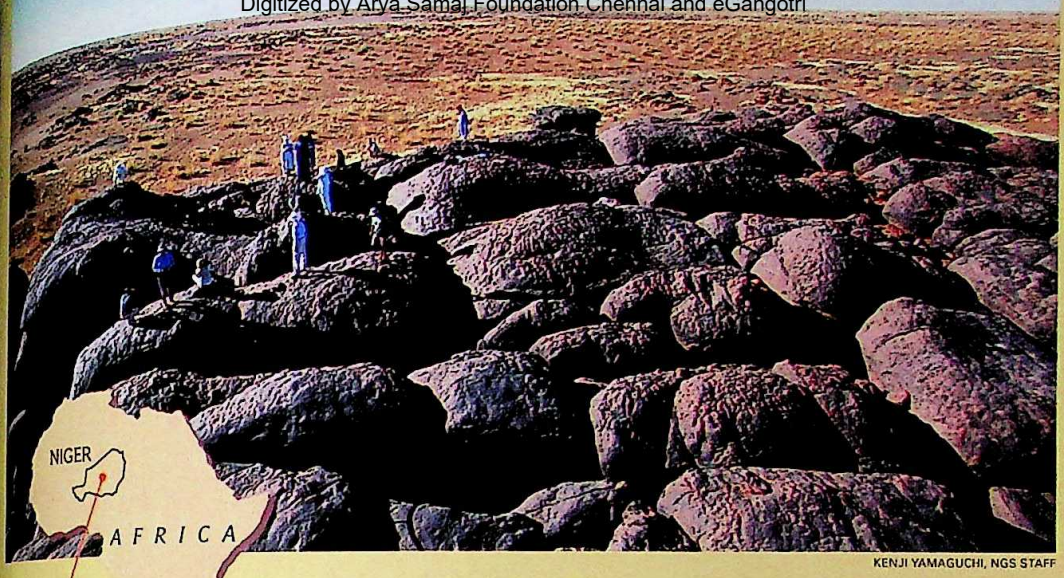


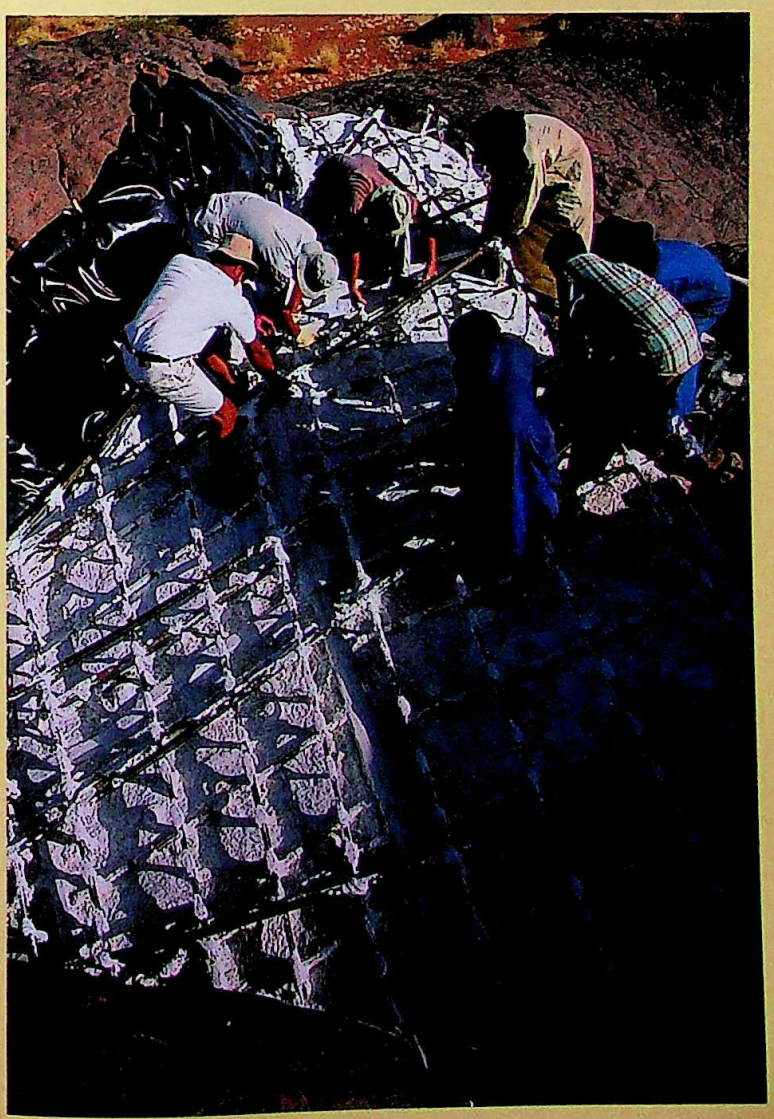
KENJI YAMAGUCHI, NGS STAFF

MAKING THE IMPRESSION

Carved by human hands some 7,000 years ago, the rock giraffes of Niger were unknown to the outside world until recently—and are at greater risk today than at any time in the past. Despite their remote location (above), they are near a road and vulnerable to vandals and looters. With help from the Bradshaw Foundation, our team set out with my colleague Alec Campbell and art restorers from Ateliers Mérindol to copy this masterpiece before it was too late. After cleaning and sealing the stone to prevent damage, we applied layers of silicone paste (left), which molded to every detail of the art. Then we assembled a metal frame over the silicone and poured a layer of nonbinding plaster of paris (right) to make a stiff protective backing for the image.

RESEARCH PROJECT

Supported in part by your Society



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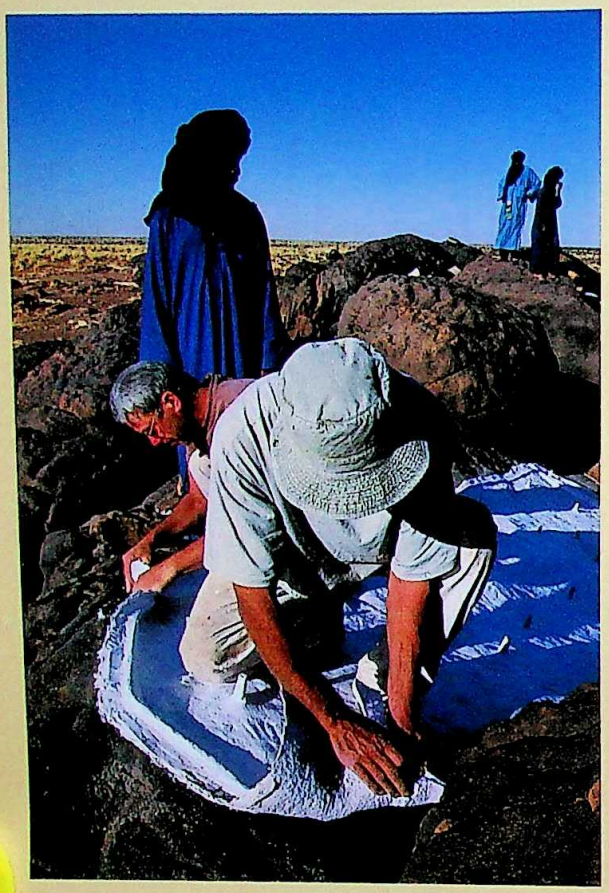

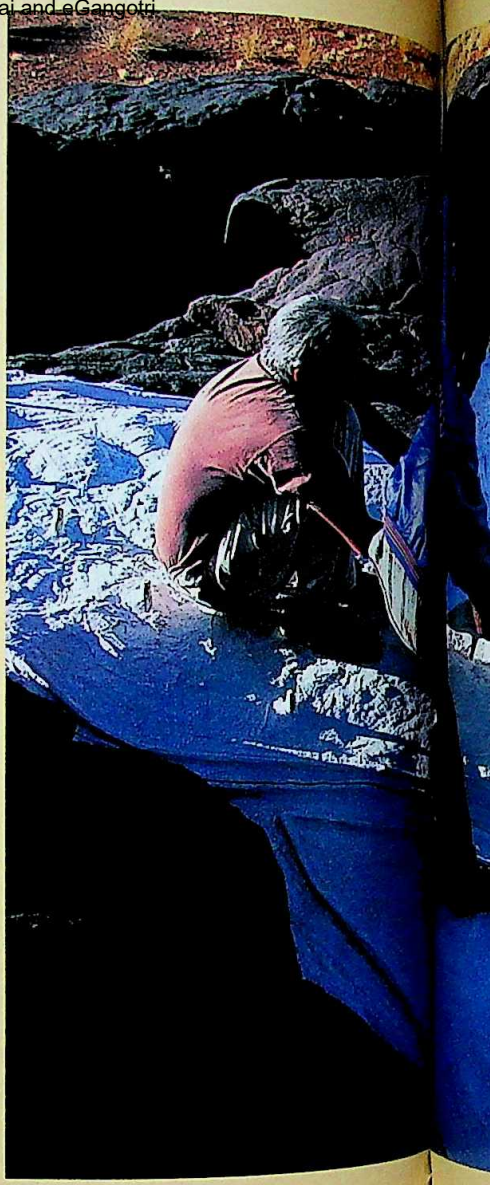

LIFTING THE IMAGE

After the plaster dried, we cut it into sections and lowered them to the desert floor, where they were reassembled upside down as a platform (right); the silicone mold remained on top of the giraffes. Then came the moment of truth. Inch by inch we carefully peeled back the image from the stone (above), folding the rubbery silicone like a carpet as each of three panels was taken up (above right) and moved to the plaster platform. When the panels were unfurled, we broke into whoops of joy and relief. For there, molded in silicone, was what one team member, rock art authority Jean Clottes, calls a "world-class masterpiece" that deserves a place in the Louvre. The mold and its plaster base were shipped to France, where Mérindol craftsmen are making the first copies. One will be presented to the Niger government, and National Geographic plans to exhibit another at its headquarters in Washington, D.C.

With this first step behind us, we can turn to the larger task ahead: taking steps to protect the giraffes and other prehistoric African artworks—we recorded some 450 engravings on this rock outcrop alone—for future generations. A key, I believe, will be involving not only governments but also local communities in the effort.

DAVID COULSON, chairman of the Trust for African Rock Art, covered Sahara art in the June 1999 issue.

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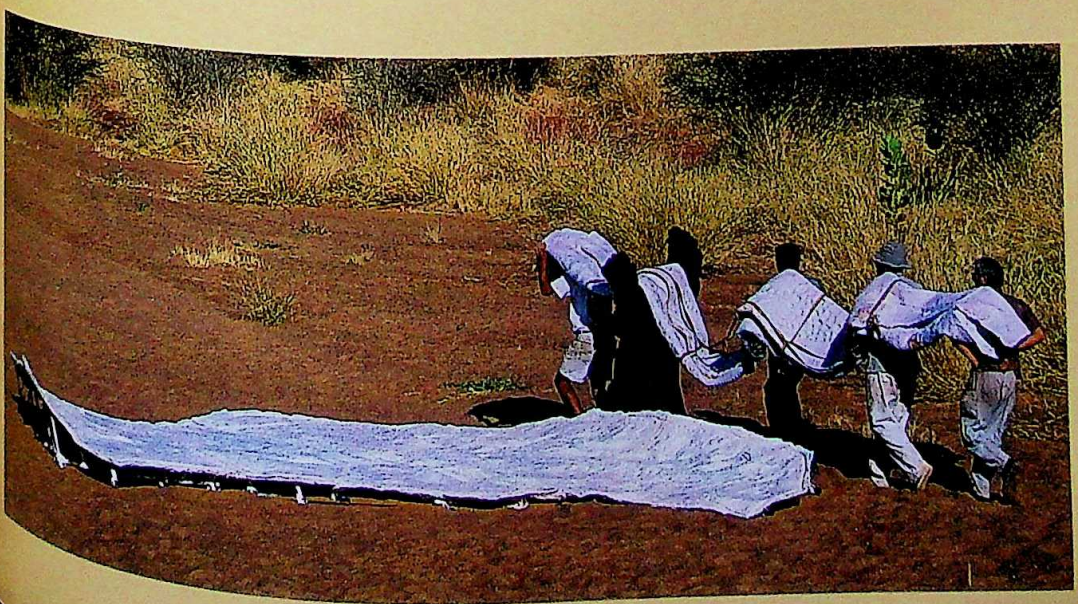

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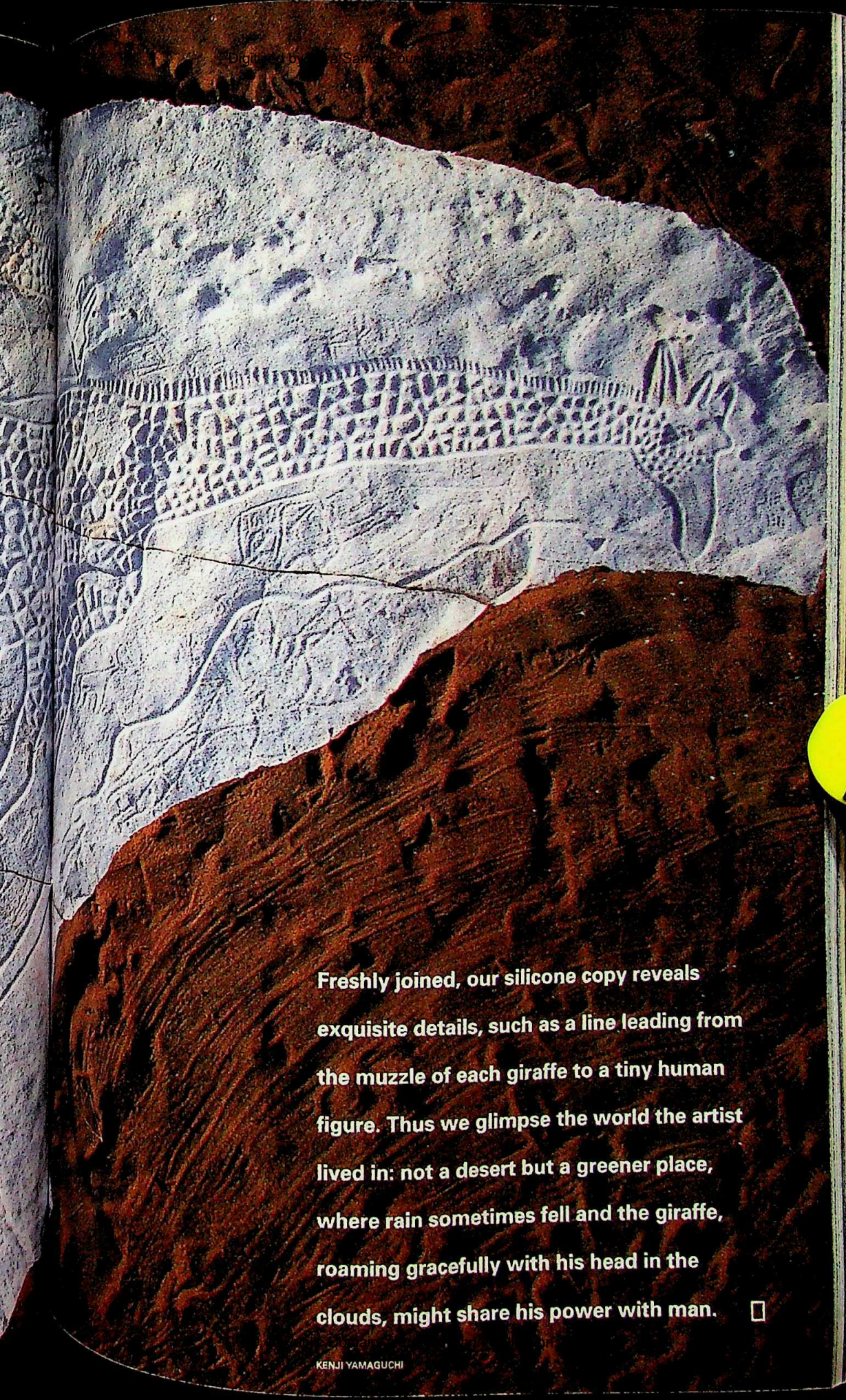

Freshly joined, our silicone copy reveals exquisite details, such as a line leading from the muzzle of each giraffe to a tiny human figure. Thus we glimpse the world the artist lived in: not a desert but a greener place, where rain sometimes fell and the giraffe, roaming gracefully with his head in the clouds, might share his power with man.

KENJI YAMAGUCHI

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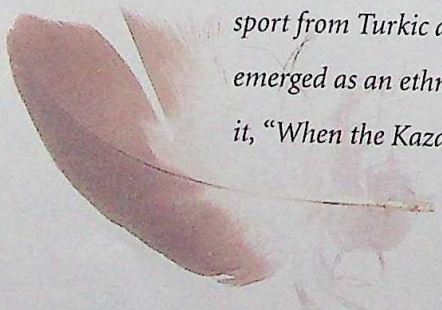
IN THE
MOUNTAINS OF
MONGOLIA

HUNTING WITH EAGLES

The hunter returns. Hackles up, she sits alert on a falconer's arm, torn meat caught in her beak. The falconer, like this young apprentice, is one of a group of Kazakhs in Mongolia who hunt with golden eagles, a tradition more than a thousand years old. Kazakhs inherited the sport from Turkic ancestors and were already practicing it when they emerged as an ethnic group in the 15th century. As one falconer puts it, "When the Kazakhs came into the world, they were eagle hunters."



By CANDICE S. MILLARD • *Photographs by* DAVID EDWARDS
NATIONAL GEOGRAPHIC EDITORIAL STAFF

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CLEARED FOR TAKEOFF

In a winter wind a veteran hunter named Kosan strains to support his eagle as she flattens her wings, seven feet from tip to tip. He often hunts from this promontory, and when his eagle pursues prey in the valley below, Kosan, in corduroy coat and fox-fur hat, jumps on his horse and races down the mountain, hoping to reach her before she damages the precious fur—or, in fighting for its life, the animal injures her.

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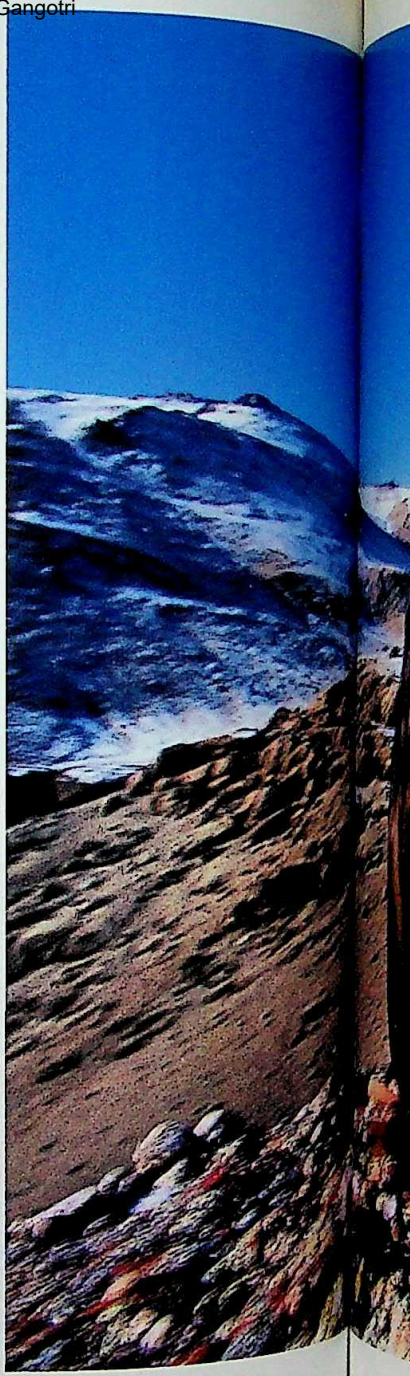
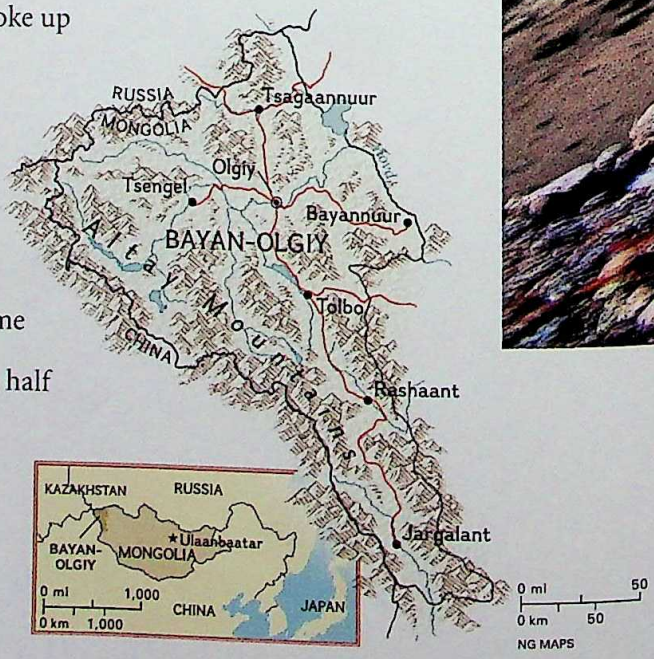


Fleeing tribal warfare in the late 1600s, a small group of Kazakhs settled in Bayan-Olgiy, Mongolia's westernmost province. A century later, after a Manchu emperor's genocidal raids had wiped out the region's Mongols, the Kazakhs took control of this dry, harsh land. Rainfall rarely exceeds ten inches a year, and the rocky soil makes farming almost impossible. No paved roads lead into Bayan-Olgiy, which is separated from the rest of Mongolia by the Hovd River and from China by the Altay Mountains. Thus isolated, these Muslim pastoralists have been able to keep their language, cultural traditions, and identity as Kazakhs. After the Soviet Union broke up in 1991, many Kazakhs left Bayan-Olgiy for a homeland they'd never known. By some estimates fewer than half the roughly 70,000 Kazakhs in the region at that time remain today.



Photographer David Edwards is a co-founder of New Land Bridge, a program promoting cultural exchange between the U.S. and Mongolia.

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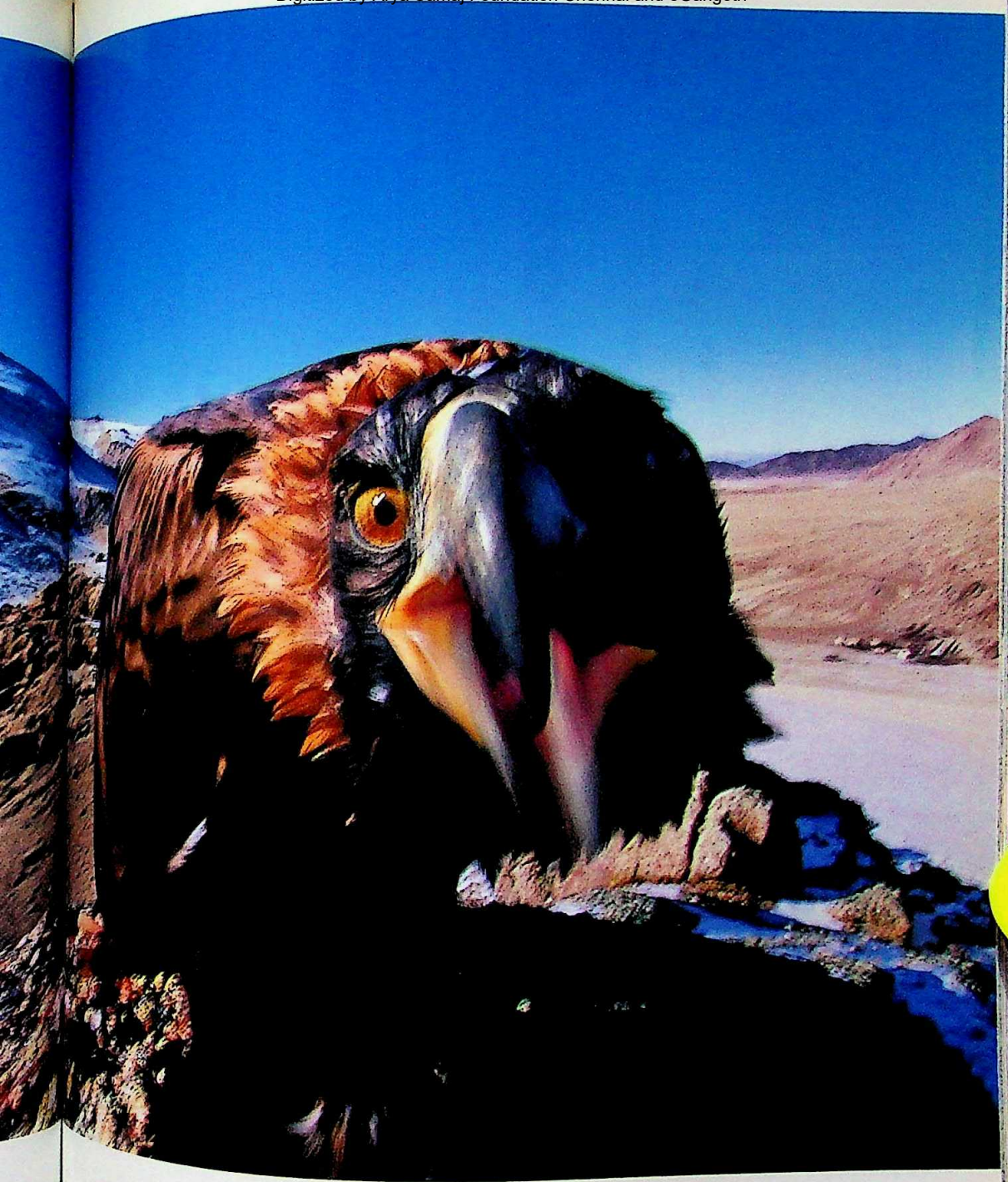

PORTRAIT OF A PREDATOR

"I've always thought of them as feathered velociraptors," says photographer David Edwards, whose proximity to a resting eagle provokes a startling lunge. In Mongolia, Kazakhs hunt only with female golden eagles, which they believe to be more aggressive. These females, which defend the nest, weigh as much as 15 pounds, nearly a third heavier than males. One of the eagle's best assets is its vision, perhaps eight times more acute than that of humans.

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TO CATCH A THIEF

In his home a hunter prepares a trap: a handwoven net, seven sticks, three frozen hares, and one angry raven. Outside, he strings the net between the upright sticks, forming a precarious circle around his bait. When an eagle dives in to scare away the raven and steal the carcasses, the trap collapses, netting her like a butterfly (top right). Taming her will be more difficult. Her ankles are bound in leather straps and tied to a wooden block on a

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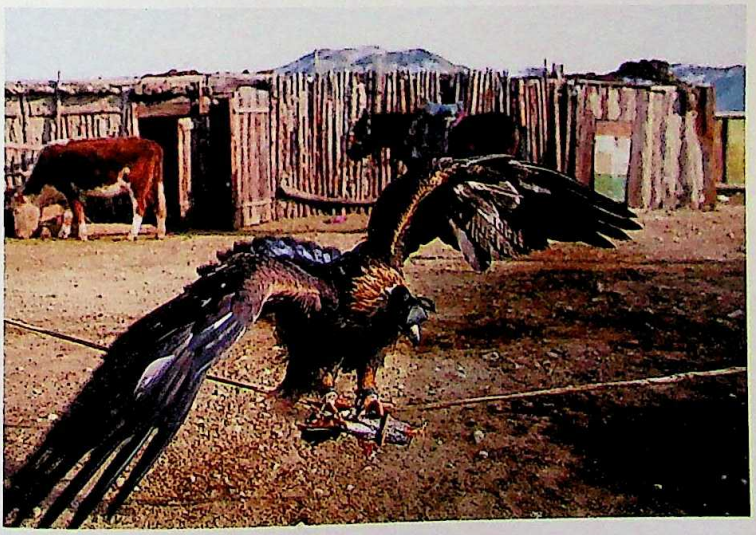

rawhide line (middle). Each time she tries to fly away, she flips upside down. She'll stay here, struggling with this tightrope, for up to two days. When she's exhausted, she's tame, and the falconer can teach her to return (right), bloody knuckled after a hunt.

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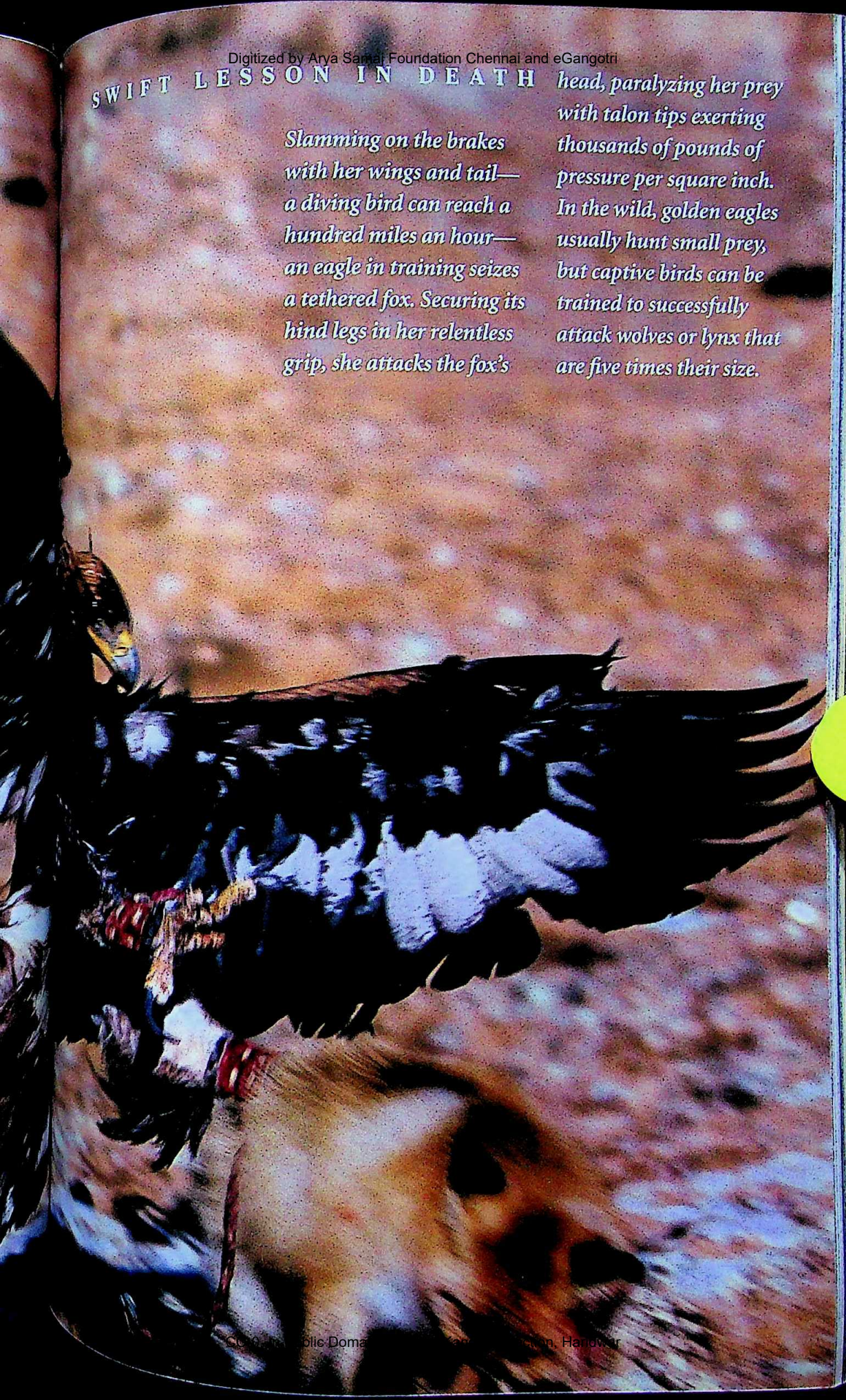
SWIFT LESSON IN DEATH

Slamming on the brakes with her wings and tail—a diving bird can reach a hundred miles an hour—an eagle in training seizes a tethered fox. Securing its hind legs in her relentless grip, she attacks the fox's head, paralyzing her prey with talon tips exerting thousands of pounds of pressure per square inch. In the wild, golden eagles usually hunt small prey, but captive birds can be trained to successfully attack wolves or lynx that are five times their size.



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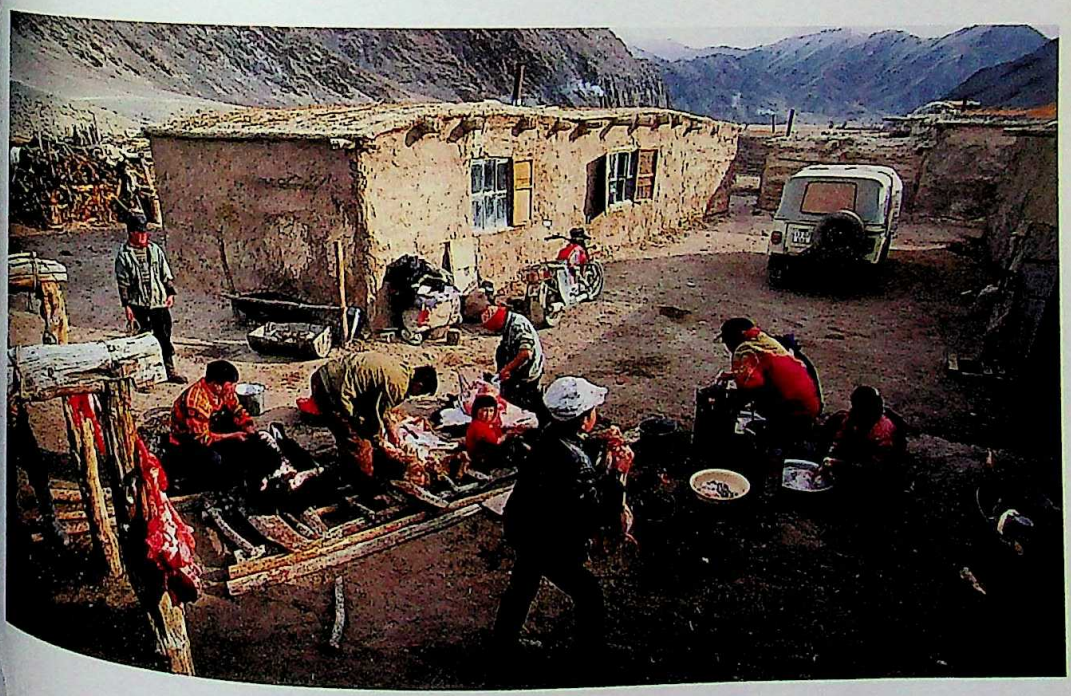
RICH LIFE IN A LEAN LAND

A young man gives thanks to Allah before slaughtering a sheep (left). He ends the prayer by wiping both hands down his face, affirming the blessing. Mosque attendance is not possible for these nomads, so religious traditions are taught within the family, as are customs that ensure survival. After the first freeze relatives gather (below) to slaughter enough sheep and goats to endure a winter that can brutalize with minus 50°F temperatures. They work for three days, killing as many as 150 animals. In the summer families move with their herds, living in felt tents called gers, *but from September through April they hunker down in wood-and-adobe homes like this one.*



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HEIR TO A TRADITION

A falconer gallops home after a hunt, his hooded eagle gripping one arm. Once the sport of the elite throughout Central Asia, hunting with eagles in much of the region has become little more than a tourist attraction—a "cultural relic," according to ethnologists. But in Mongolia the tradition lives on among the Kazakhs, who proudly practice the sport they learned from their fathers and teach to their sons. ▯

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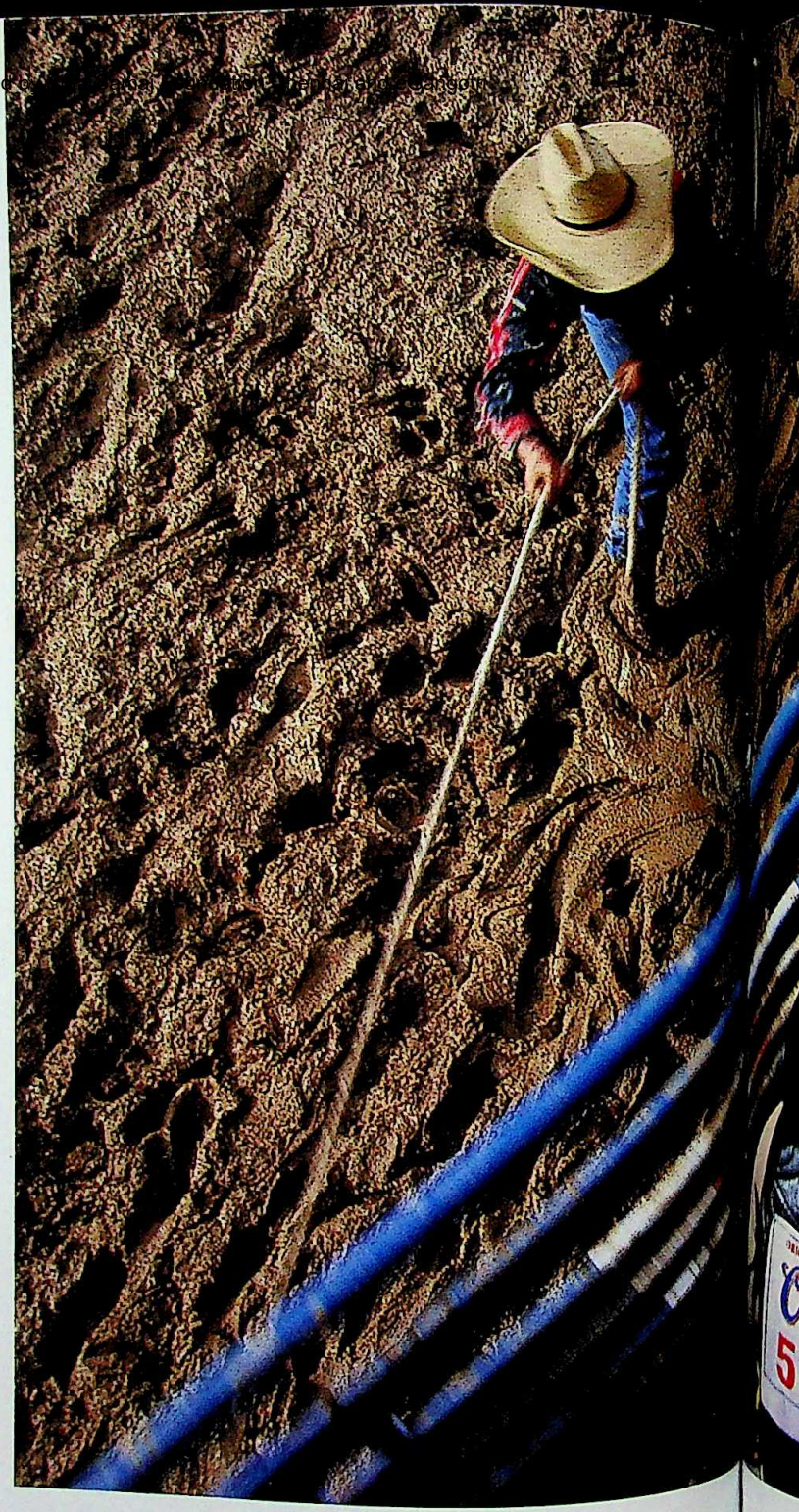

Moments from pain, bull rider Brian Smotherman holds on for a last instant before the chute gate opens. In less than eight seconds he'll be down hard on Tucson dirt with a separated shoulder, a casualty of the roughest event in the rough sport of rodeo. Professional rodeos—about a thousand a year—thrive today on romance, nostalgia, and the utter devotion of their hard-driving cowboy stars.

R O D

By MICHAEL PARFIT

Photographs by WILLIAM ALBERT ALLARD
NATIONAL GEOGRAPHIC PHOTOGRAPHER

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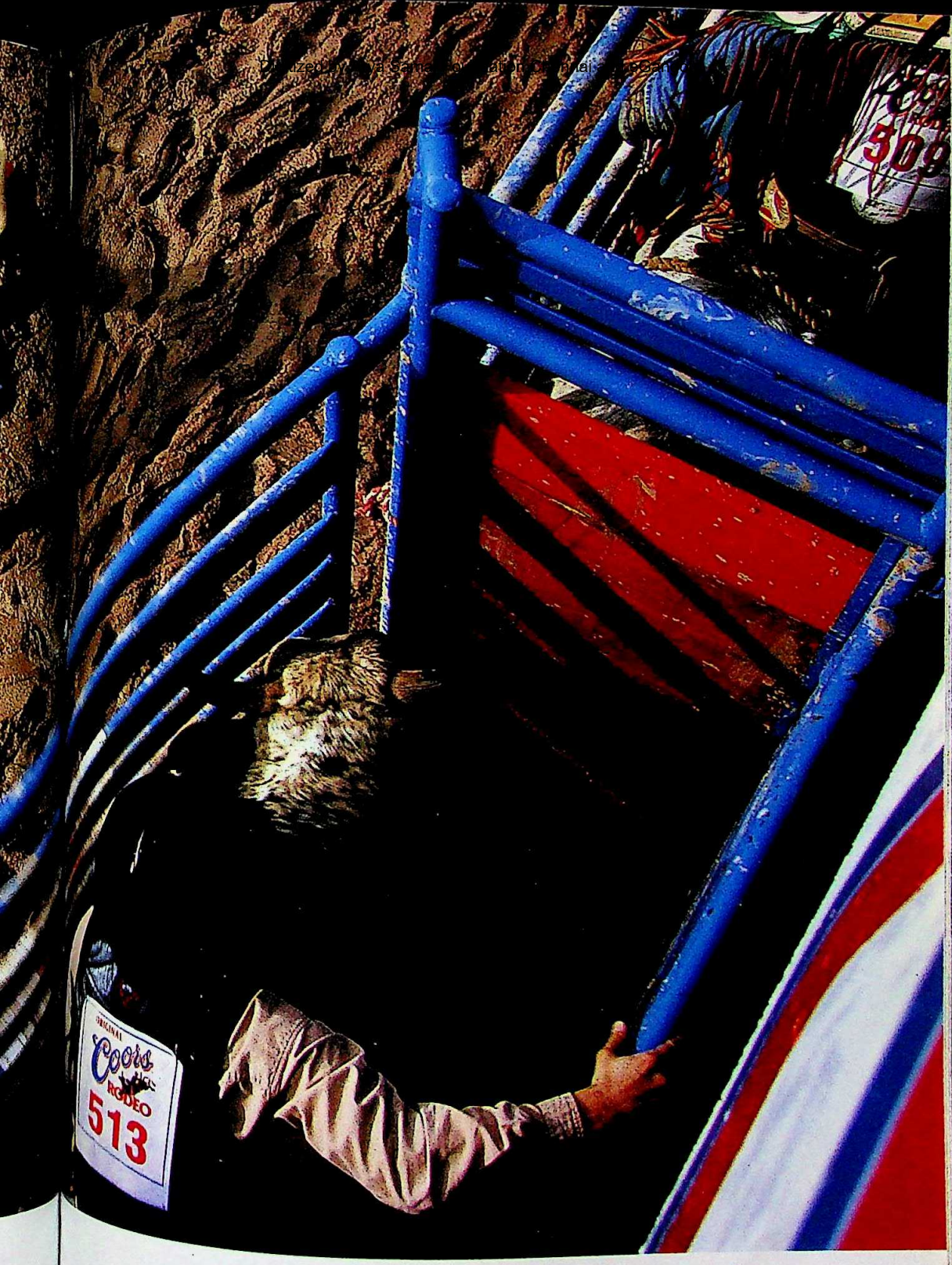

Behind the Chutes

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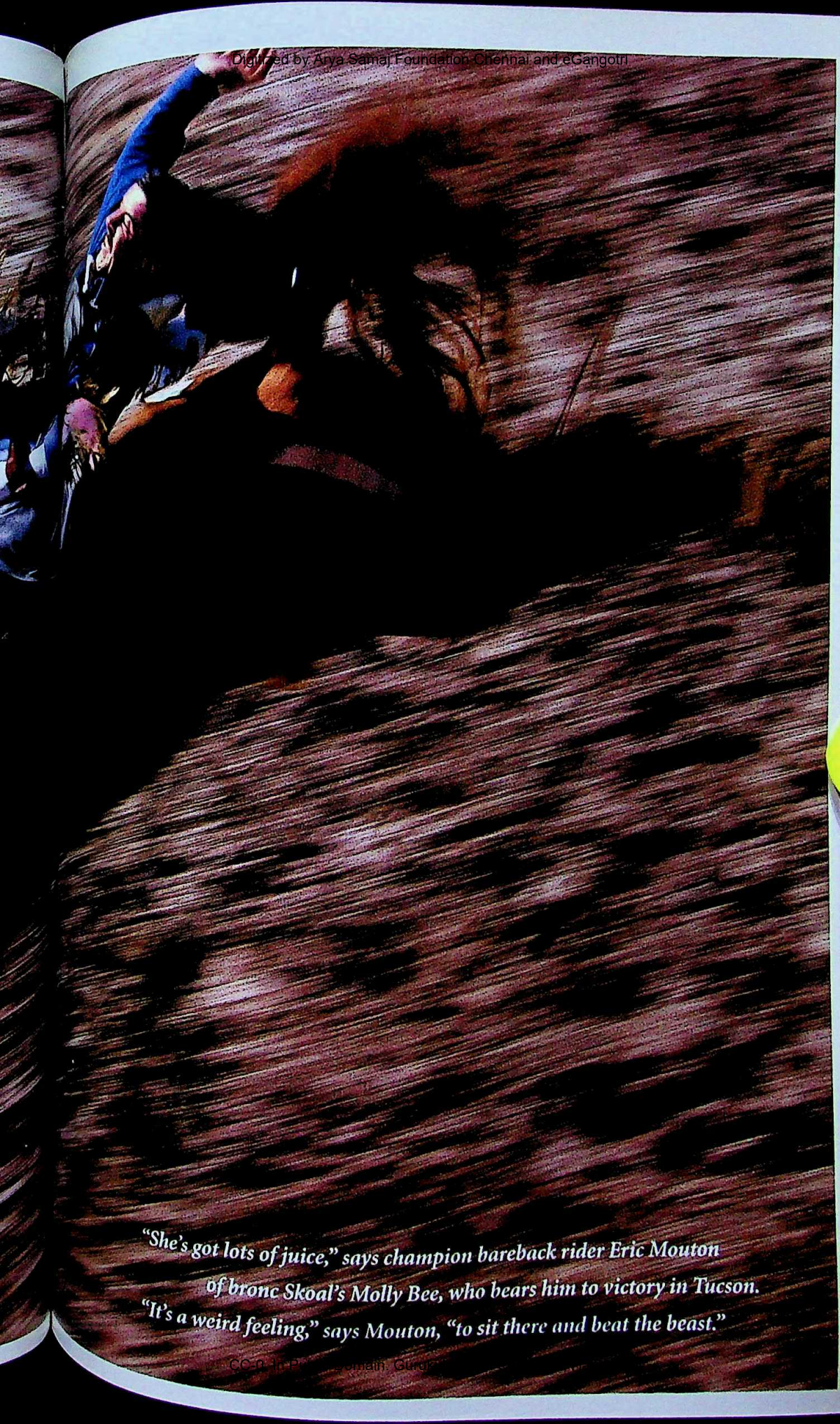

"She's got lots of juice," says champion bareback rider Eric Mouton of bronc Skoal's Molly Bee, who bears him to victory in Tucson. "It's a weird feeling," says Mouton, "to sit there and beat the beast."

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In the medical room far behind the chutes, cowboys were talking about the day a bull's hoof cut off Charlie Sampson's ear.

Rodeo may be "bulls and blood" in a Garth Brooks song, but clown Frank Newsom's job is to prevent bloodshed. That often means getting thumped himself. "The bull has that guy in his sights," says Newsom, "so you dang sure got to let him get a piece of you."

"Rob Smets found it in the dirt," one of them said. "He was holding it in his hand, and Leon saw it and he was puking, and Charlie was crying because he thought his career was over, but how could your career be over as a bull rider just because you lost your ear?"

Meanwhile, out by the chutes cowboys were praying for victory and their lives, and then all the hats came off because the flag rode in. Another rodeo was under way.

Crude, rude, and socially unacceptable. That's rodeo. Patriotic, honorable, moral, all-American. That's rodeo too. But after a season behind the chutes, watching rodeo from the intimate place where cowboys go to work, I was no longer startled by rodeo's contradictions. The world of rodeo is violent but sweet, harsh but full of affection, profane but religious, obscure to most of the American public but central to our roots.

"This is where we came from," Bob Tallman, an announcer at many rodeos, once boomed to the crowd during a celebration of rodeo's history. Tallman, with his rough eloquence, always sounds as if he was born in a Southern Baptist pulpit and raised on syrup and sleet. "This is where we are," he said, "and this is how we hope to lead the world."

On a stormy June day in Belt, Montana, I climb a fence, walk through mud and manure, then climb another fence and find myself on a platform just behind the chutes, the stalls where horses or bulls are penned before they're turned loose to try to shed cowboys. Like every other place behind the chutes, it smells of manure and is stained by tobacco juice. And it is oddly private. Not many spectators watch what goes on back here, because out front of the chutes is where the action is.

But the place behind the chutes is the center of rodeo. This is where cowboys go to ride and older rodeo hands go to help the cowboys or work with the animals. This is where the big names of rodeo go, even when they're not riding—people like Ty Murray, seven-time champion all-around cowboy, or Charlie Sampson, the legendary retired bull rider with one false ear—because here they feel most at home. Back here tough men dance to keep loose, a lot of men seek their Maker, and a few men say their last words. Old men of 30 pass hard-won wisdom about the length of a rein or the nature of courage to young men of 19, and

MICHAEL PARFIT, a frequent contributor, lives in Montana, a state noted for producing some of the best saddle bronc riders in America.

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everyone learns the meaning of the noun "try."

Behind one of the chutes a stocky, good-natured, 28-year-old Montana cowboy named Jess Martin is getting ready to get on. Rodeo cowboys don't say they are going to ride; they say they are going to *get on,* because for a cowboy the act of decision—and courage—is to climb aboard whatever animal awaits. What happens after that may be long enough to be called a ride, or it may not be.

Jess measures the length of his rein with his palm. Too short and the horse will yank him forward; too long and he'll be flung back. As he prepares, men by the gate watch his face, waiting for him to nod his head that he's ready.

Jess once told me that he likes this sport better than any other. He was good at a lot of them; he got a football scholarship to college. But football ended when he tried rodeo.

"I got on," he told me, "and I nodded, and he bucked me off. Right then I knew that's what I wanted to do and do it good."

As Jess settles carefully down on the saddle, I look around the arena. Belt has a population of 600, but thousands come to its annual rodeo. Beyond the full stands, hills roll out into the big wheat-striped landscape east of the Rockies. This is the kind of place rodeo came from. The legend is that it began in the mid-1800s when men driving cattle up the trail from Texas to the northern plains started to compete in the activities they did on the trail: roping steers, breaking colts, enduring pain.

The horse Jess is getting on, named Footloose, shifts his position. There's a moment of tension behind the chutes and out in the arena. This happens at every rodeo. The crowd noise seems to fade, *(Continued on page 114)*

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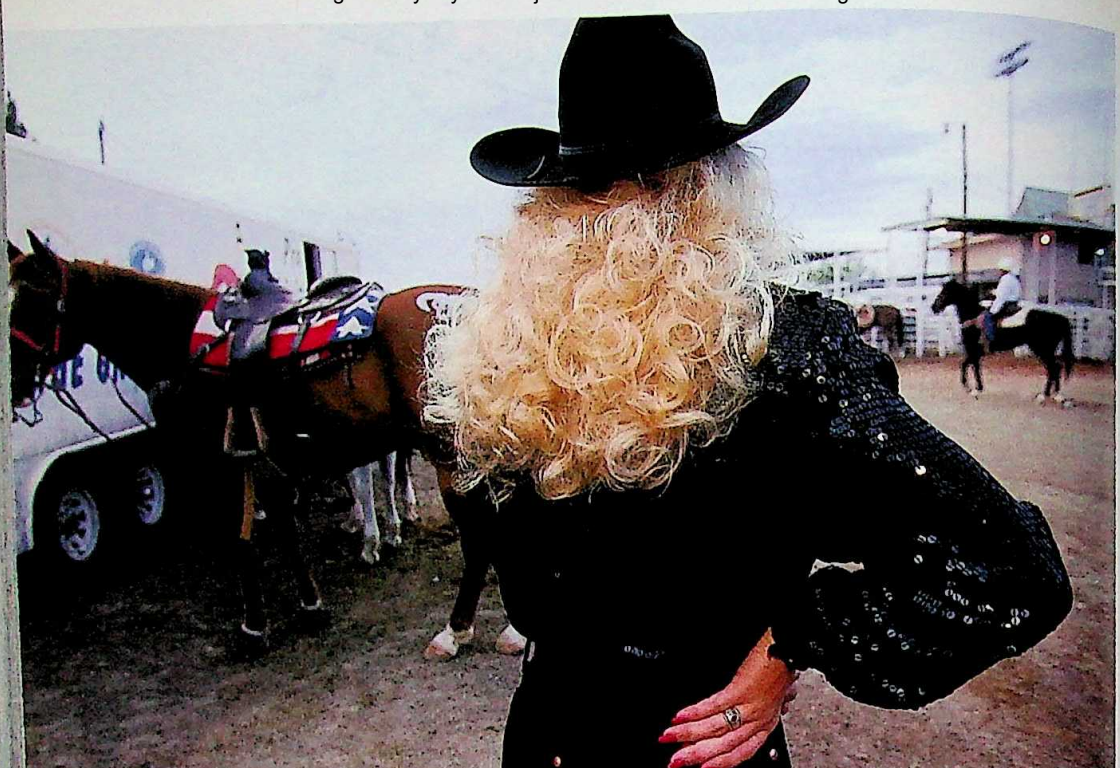
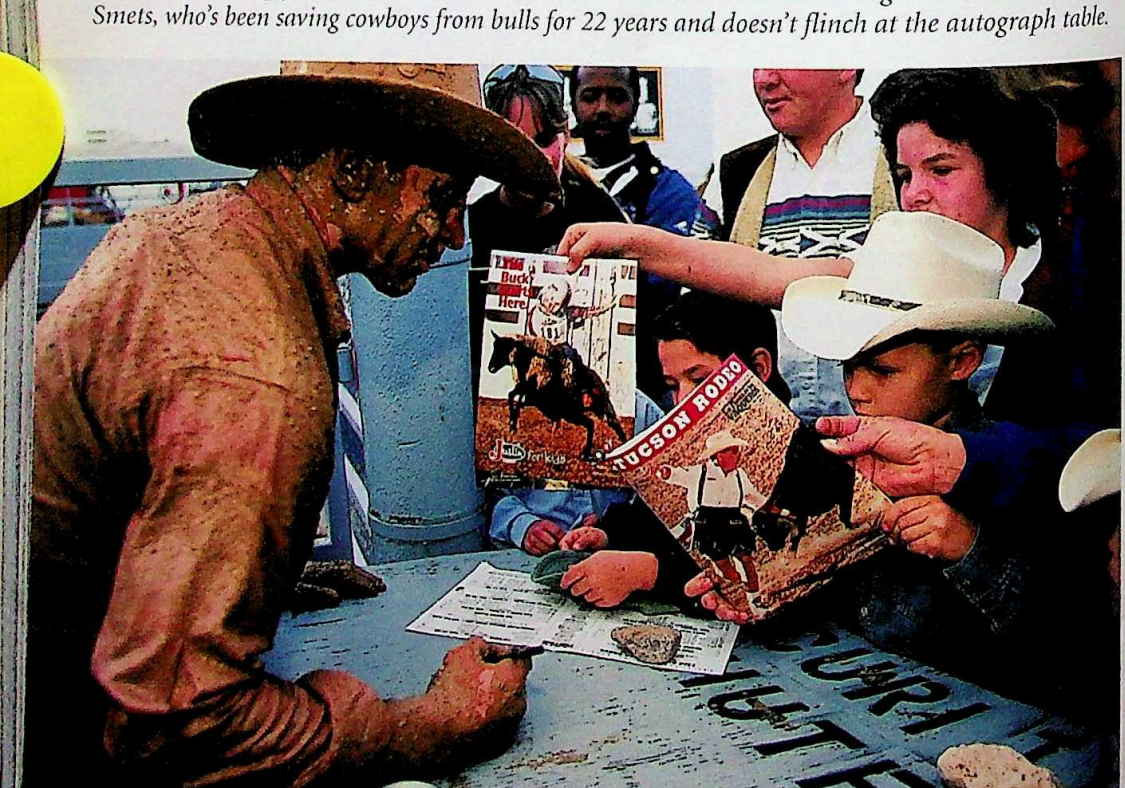


Rodeo outfits come fancy and plain. "I wear a lot of sparkle-type stuff," says Danyelle Rideout (above), geared up for a ceremonial ride in Pecos as Miss Rodeo Texas. True grit covers clown Rob Smets, who's been saving cowboys from bulls for 22 years and doesn't flinch at the autograph table.



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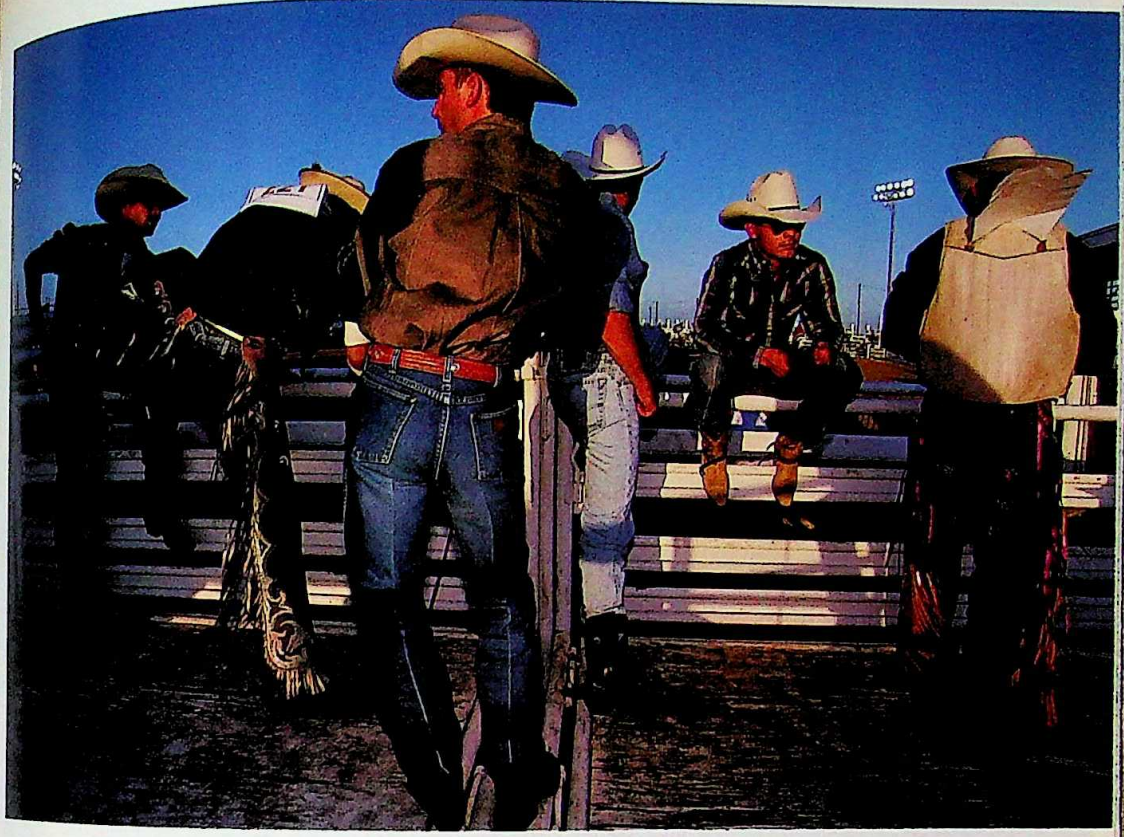

Cowboys stretch, adjust equipment, think a lot—but don't talk much—before the rodeo at Pecos. Some rodeo cowboys are Indians, and the Pendleton Round-Up in Oregon celebrates them with a tepee village, where Acosia Red Elk, American Indian Beauty Pageant winner, waits for a parade.

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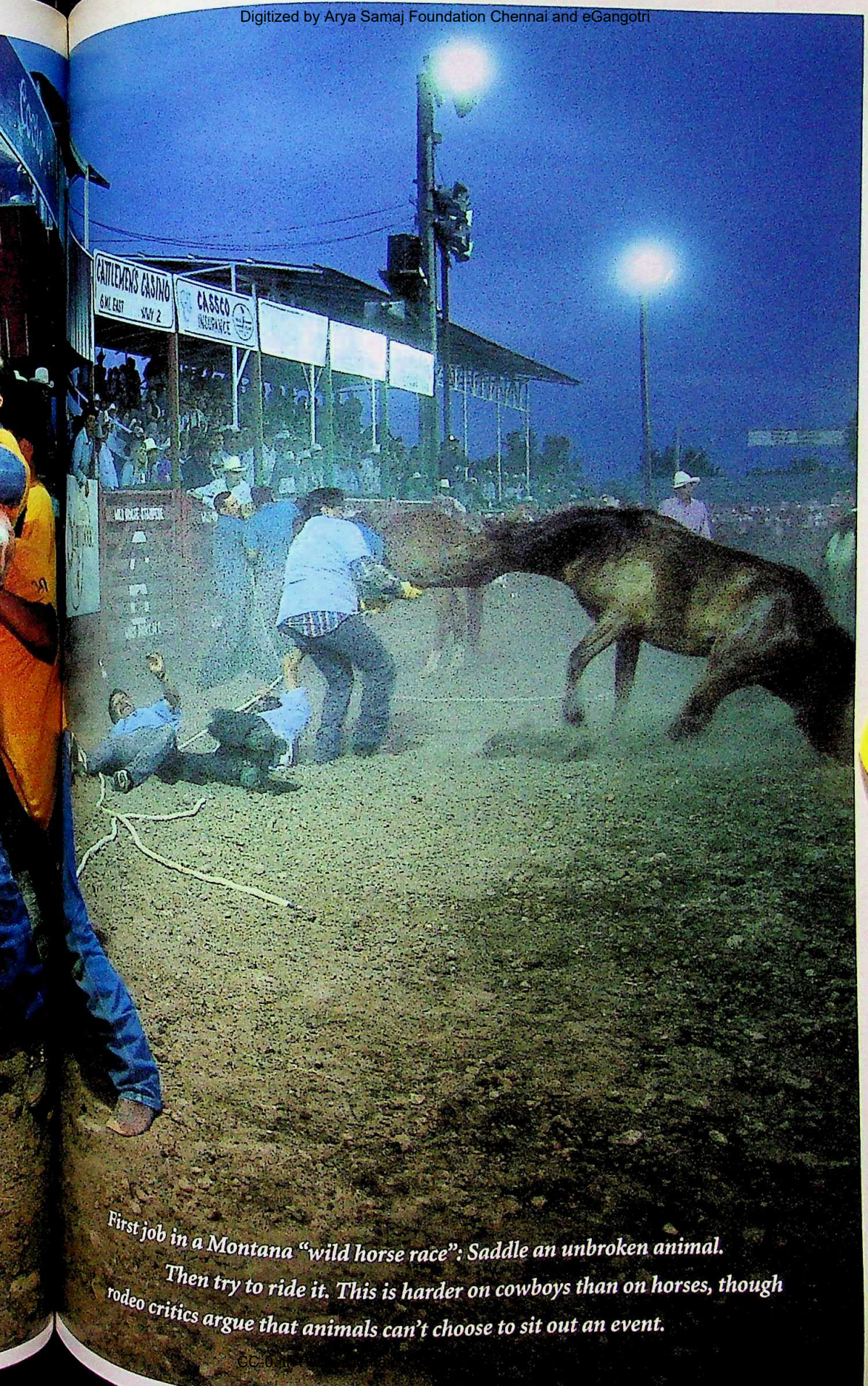

First job in a Montana "wild horse race": Saddle an unbroken animal. Then try to ride it. This is harder on cowboys than on horses, though rodeo critics argue that animals can't choose to sit out an event.

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(Continued from page 109) as if a collective breath is held. Everyone waits for Jess to nod.

Several places claim to have put on the first official rodeo—Pecos, Texas, and Prescott, Arizona, among them. After the century turned, the Wild West shows turned rodeo into two very different things: a rough sport for young men with horses on their minds and a romantic symbol of a favorite fable of America's roots—the cowboy.

"The rush is so high because you know you're going to cross the line, and death awaits you over there. You cross the line, and then you get back."

In the latter role, rodeo has sold a lot of jeans, compact discs by Garth Brooks and Chris LeDoux, chewing tobacco, and beer. But one of the contradictions of modern rodeo is that many of those urban customers have only a faint idea of the young man's sport itself.

There are about a thousand professional rodeos every year in the United States and Canada, and countless other amateur events. But rodeo has only about 25 million spectators a year. This is just a single grain in the feed bucket compared with auto racing or baseball. The reality of rodeo is hidden in small western towns—or in annual events in big cities that are attended mostly by people from small western towns.

Rodeo evolved from displays of the skills developed to trail cattle, to catch them for branding, and to break and ride horses. At events sanctioned by the Professional Rodeo Cowboys Association (PRCA), like Belt's, the contests of these skills have been refined into seven main events for men—saddle bronc riding, bareback riding, bull riding, calf roping, steer roping, team roping, and steer wrestling—and one event for women, barrel racing. The show is held together by continuous patter from an announcer who conducts a raunchy repartee with a clown who tells jokes like this:

Clown: "I got beat up by my wife last night."

Announcer: "I thought your wife was out of town last night."

Clown: "So did I."

At Belt right now the clown is silent. Across the hushed arena a voice echoes out: "Bear down, Jess!" At last the brim of his hat dips. The gate opens, and Footloose erupts.

Out in the arena the horse looks like a classic bronc, rearing and kicking. From behind the chutes he looks like a berserk freight locomotive, flinging hoof-loads of mud that hit people in the face at long range. Jess grips the rein with his left hand and holds his right arm high, where it whips around. Eight seconds later the whistle blows. He has made it. He jumps to the dirt and walks slowly back to the chutes.

Rodeo is seen as a simple and honorable sport, but the scoring of the roughstock events—saddle bronc, bareback, and bull riding—is complicated and subjective. A score is based on style and difficulty, much the way it is in gymnastics. Out of 100 possible points half are for the cowboy and half are for the animal. So a lot of a cowboy's score depends on how good an animal he gets in a random drawing. And judges' decisions are, well, debatable.

Jess's ride gets 74 points. That's good for a tie for first place and a check for $312. But like most modern cowboys, Jess is not off to buy his friends a few rounds. Instead he'll be on the road in his diesel pickup truck, starting on the thousand-mile run to Reno, where tomorrow he'll get on a horse named Ram Power.

Today's professional cowboy has one goal: to reach the National Finals Rodeo (NFR), which is held in Las Vegas every December. Qualifying is straightforward. There are no championship brackets or polls. The NFR just takes the year's top 15 money winners in each event.

To get on that list, Jess, like most pro cowboys, will enter more than a hundred rodeos this year. And since most cowboys gross far less than $50,000 a year, these guys are not getting around in jets. Most traveling is done in cars or trucks, like Jess's club cab. On big weekends like the Fourth of July, during which cowboys sometimes enter three rodeos each day, the most successful riders may charter a small plane.

All for the chance to get on, again and again and again.

"I loved playing football," Jess told me, "but it's nothing like this. When you are on a great bucking horse and you're sticking it on him, it is—unexplainable. You're pretty much addicted to the adrenaline."

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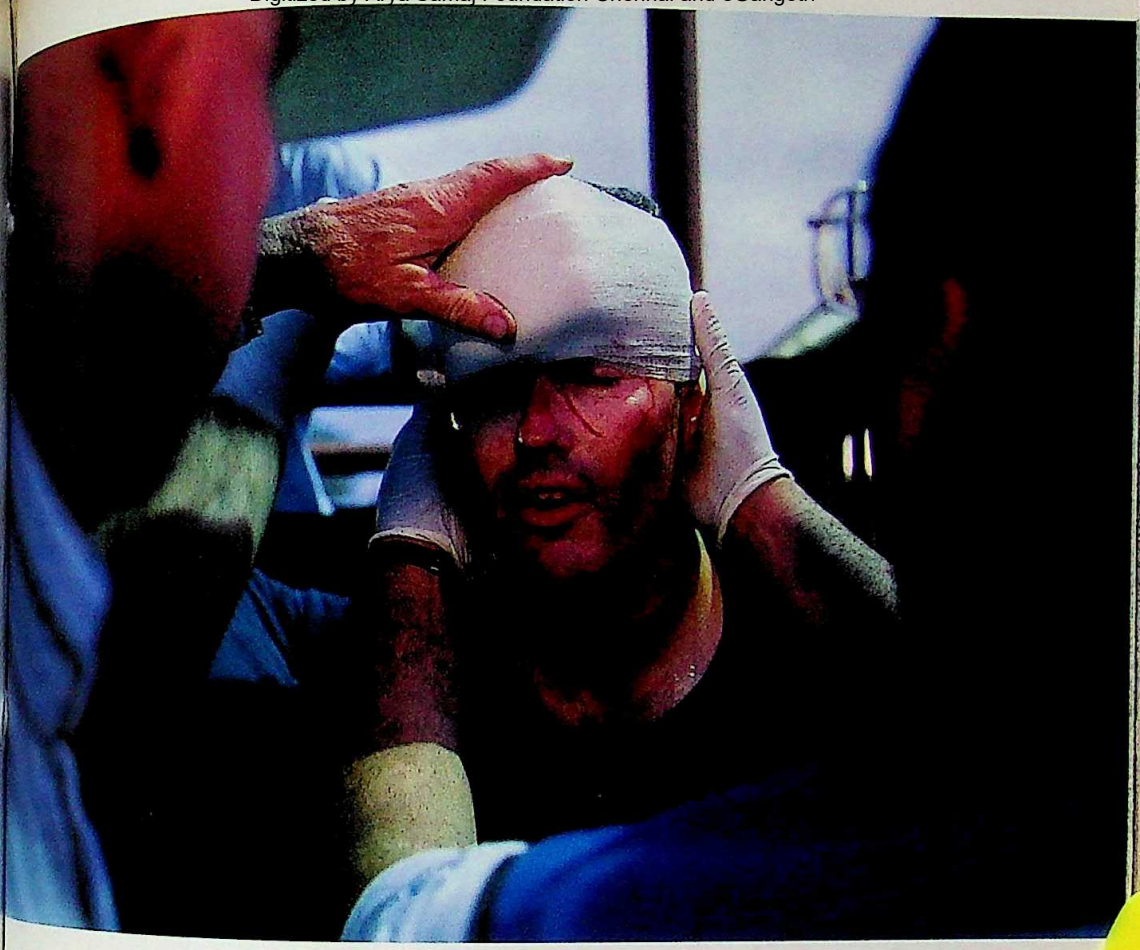

"Everything was vague," says Roger Nygaard, kicked by a horse in Montana. Pain is as common as chewing tobacco, but, says Tuff Hedeman, a famously battered star, "I never think about it."

"This is a brutal sport," says Lyle Sankey. "Not many of you are going to pursue it for any length of time." Chutes and fence are all there is of this arena out on the flats of West Texas, near Lubbock. I'm behind the chutes on precarious planks, watching students at Lyle's roughstock riding school get flung off one after another onto the dirt.

It's a varied group. There's a young anthropologist from Virginia, a 47-year-old man with a big mustache who wants to ride for charity, three Australian men living out of a $300 car they call the Green Snot, and a woman named Fiona from Newcastle upon Tyne, England, who went wing walking a few weeks ago and now wants to ride a bull.

Sankey, once a rodeo star, is big, energetic, and full of advice. Like all rodeo rhetoric, his meanders from the practical to slogans for life. "If you don't trust your rope, don't ever put it on a bull."

"There's no sellout point. You can't fold your tent, or they'll do it for you."

By the time the school is over, the 47-year-old has lost half his mustache to a swift, sharp hoof, Fiona will spend the rest of her vacation on crutches, kicked in the knee, and I've found a good slogan for myself. It's about being on a bull, but I think it applies to everything.

"Your perception is 'I'm toast,' " Sankey says. "But you're OK."

Cody Custer squats on the concrete behind the chutes at the famous Calgary Stampede, hat in his hands, praying. Many bull riders pray openly, and there's good reason for it. Bull riding is the most dramatic event of rodeo, partly because it is so dangerous.

"Every year kids die riding bulls," John Growney told me. John is a lean, energetic stock contractor, which means he supplies the

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"Bear down!" cowboys shout to a rider in Belt, Montana, while the bull's owner yanks a flank strap around its belly. The strap encourages bucking, but cowboys insist that it inflicts no pain.

animals. "Bull riding is one of those things for a modern man who understands that death is wrong but who still gets excited about seeing that guy die or almost die."

But when that hush breathes across the arena before the first ride, everyone wonders: Why do these boys do it?

"Bull riding is just a rush," said Growney, who has done it. "I believe the rush is so high because you know you're going to cross the line, and death awaits you over there. You cross the line, and then you get back."

Cody Custer's eyes are almost black. As he prepares, they seem to become darker. "When I'm getting ready," he told me once, "I get real quiet. I don't pal around with my buds. I do a lot of stretching, and I pray for a clear mind."

That's not necessarily what bull riders get.

Once I saw Cody bucked off onto his back. He got up, looked up in the stands, and fell over as if he'd been shot. He got up again, and fell over again. When the medics got to him, he was saying over and over: "Mom and Dad are up there. Mom and Dad are up there."

All he had was a mild concussion. Nothing at all to a rodeo star. "If you haven't had a concussion yet," said Lyle Sankey at his school, "you haven't rodeoed much."

Another day, another busted-up cowboy. This time it's John Johnson, and he has just broken his collarbone during a summer rodeo in Santa Barbara, California.

"You son of a bitch!" John says to his friend Michael Stewart. "You turned out for me. You shouldn't have done that!"

John is faking anger because Michael, a bareback rider, has just "turned out"—canceled his ride at another rodeo—so he can take John to the hospital. "I'm not going to go off and leave him here," Michael tells me.

Rodeo is violent but tender. Because of their low incomes, cowboys team up to travel. The

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friendships this creates seem sweet and gentle, for all the profane banter. Behind the chutes you see these bonds at work as traveling partners help each other with their rigging or by pulling a bull rope. And when someone gets hurt, it's typical for a guy like Michael Stewart to give up the chance to get on, to give up the rush, in order to help his friend.

"Rodeo people are like family," a young bronc rider once told me. He thought about it, then said, "They're *better* than family."

Behind the chutes in Santa Barbara the first few rows of the stands seem full of young blondes. They ask for pieces of paper from my notebook so they can write down cowboys' phone numbers. The term for them is buckle bunnies.

They all watch eagerly when it's time for the bulls. But two cowboys, Brock Mortensen and his brother Judd, aren't here yet.

This is typical of cowboys' fast-paced lives. As their event begins, the Mortensens are racing up the highway from another rodeo. About five minutes before they lose the chance to get on, they come barreling in, pulling on their flak jacket vests, a recent rodeo innovation that has saved a lot of ribs—and lives.

Brock is first and gets 73 points. But his brother has drawn a good bull and has a romping ride, greeted by cheers.

And suddenly in the sweet, dusty California air, for just one moment, rodeo is perfect for one thin young man from Idaho. The great fast drive across the desert, the great blondes waiting in the stands, the great bull, the fine ride. The whistle blows, he gets 86 points, and he throws his hat into the sky.

"Rodeo is just an old Chris LeDoux song," another bull rider told me, and Judd's joy reminds me of what LeDoux, a former bareback champion, wrote about this boyish life:

Chewin' snoose and spittin' in a bottle
With country music blasting off the radio
Talking girls and broncs and gold belt buckles
Rollin' south to a California rodeo

Just rollin' down that great American highway
With the morning sky lit up like a flame
Chasin' dreams and following a rainbow
Like children runnin' through the rain

"People talk about the romance of rodeo," LeDoux told me one day, just before he taped a satellite network show. "That word threw me for years. I'd think dust and flies and heat and wind—romantic? But I think they're talking about having your freedom. It's just living life as free as you possibly can." Like many young cowboys, that was all he had ever wanted.

"I used to have this fantasy," he said, "how I wanted it to end. I'd be at the height of my glory—maybe I could be riding Cheyenne—and a horse would throw me off and kill me."

IT SEEMS TOO DARK behind the chutes in the covered stadium called the San Francisco Cow Palace. The dark ceiling, the dark stands, and the dark earth of the arena eat light. I stand on steel grating in a crowded space crossed by greasy poles on which chute gates hang, jammed between the arena and the announcer's stand, where Bob Tallman weaves sugary braids of eloquence.

"The Cow Palace is old, dingy, and dark," a PRCA official told me of this place, "but there is so much tension there."

"People talk about the romance of rodeo. . . . I'd think dust and flies and heat . . . romantic? But I think they're talking about having your freedom."

It's November. It's the last weekend of the PRCA season before the finals, and if you're anywhere close to the cutoff point in the rankings—which the cowboys, like other athletes, call "being on the bubble"—you have to win money at the Cow Palace.

"There are a lot of heartbreak stories here," says Todd Fike, a bronc rider. The Cow Palace is all about heartbreak, pain, and "try."

"Try" is the cowboy's bottom line. It's the most important noun in the unique language spoken back of the chutes. It is effort, energy, and that familiar sporting term, heart. The best thing you can say about a cowboy is that he has "a lot of try."

"Try" means many good things, like persistence and courage, but there's a shadow in it from one of the darker sides of rodeo: the abundance of pain. *(Continued on page 122)*

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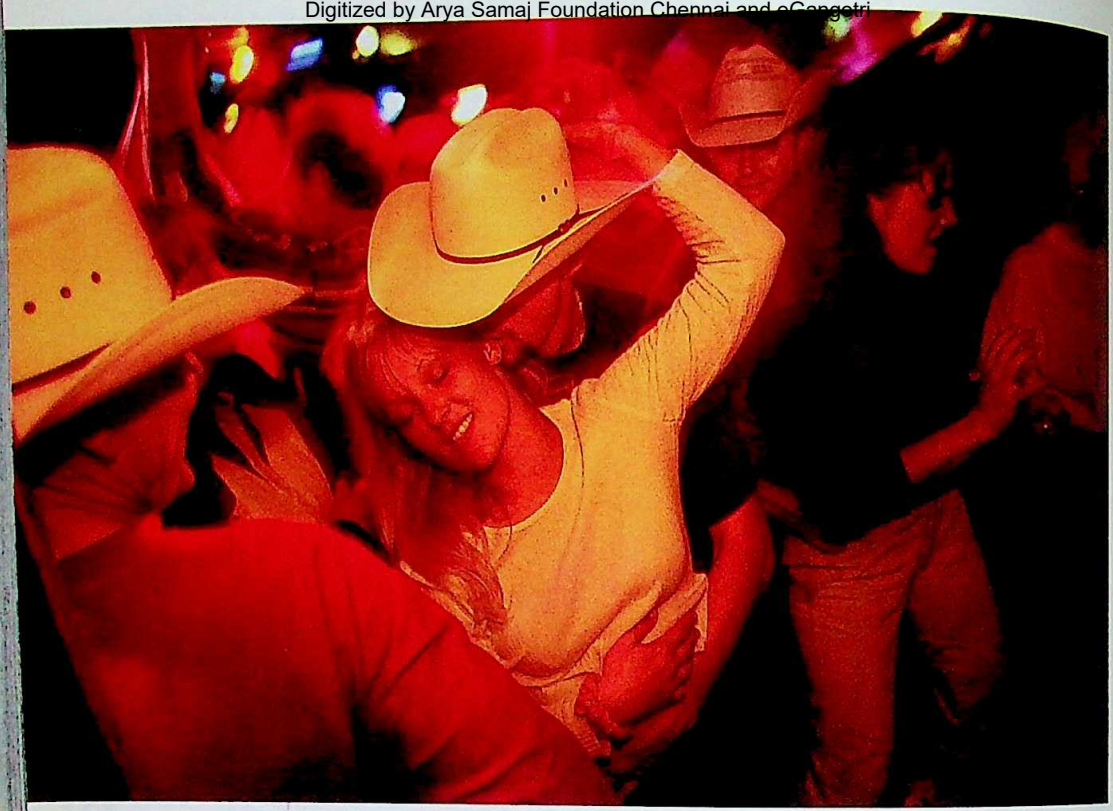
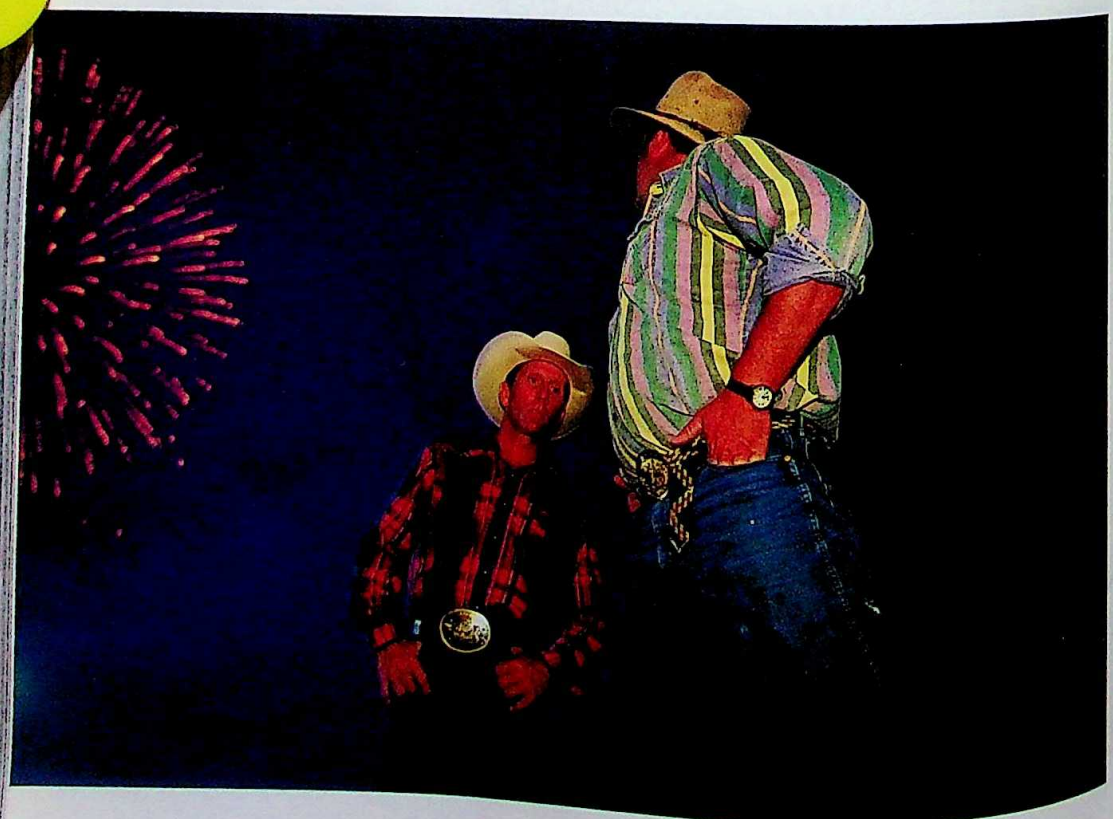


Outside the arena, rodeo sparkles on, whether in romance at a bar after the Pendleton Round-Up or in Wolf Point, Montana, where the belt buckles of self-described "old cowboys" Jim Gibbs, at left, and William Lang compete with fireworks to light up the night.



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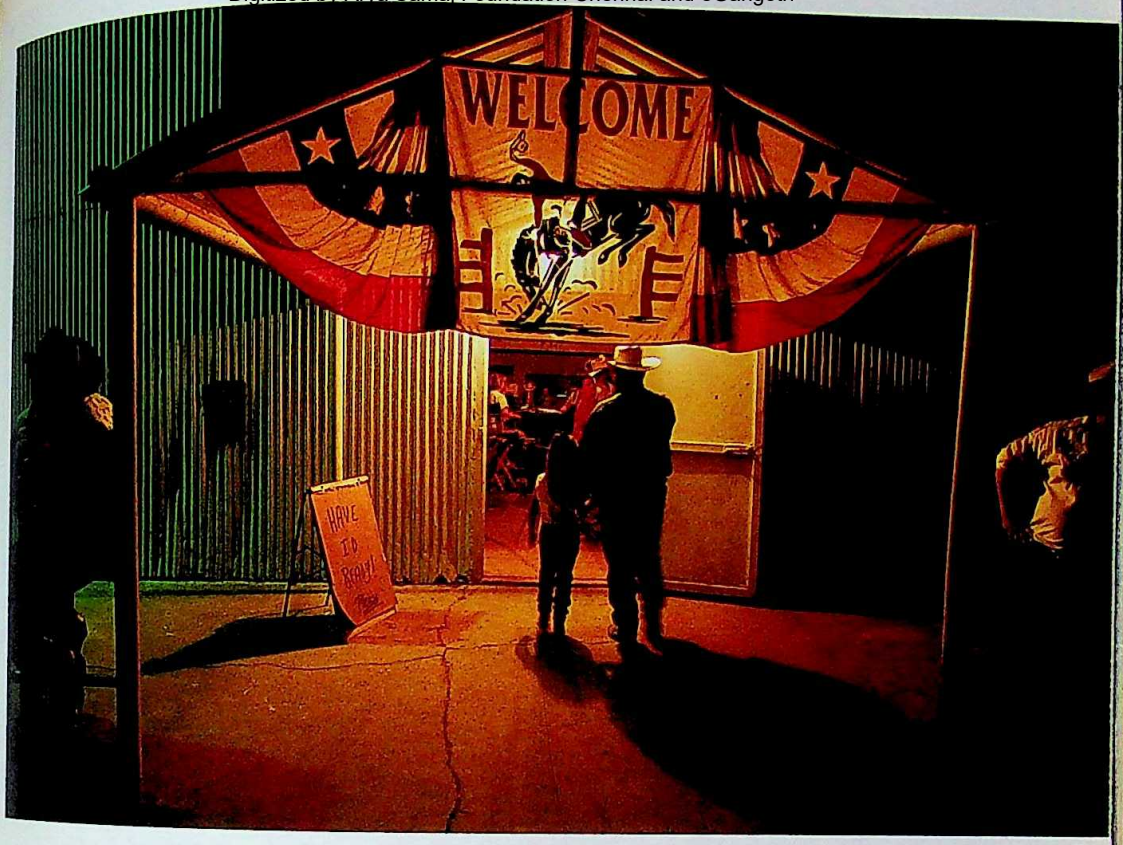

Father and cowgirl head for a dance after the Pecos Rodeo. During the National Finals Rodeo in Las Vegas (below) kids go to the arcades and cowboys go to the casinos, where you can let it ride at the table for a lot longer than the eight seconds you have to stay on a bull to score.

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As he lands hard, silver spurs on steer wrestler Coty Battles glint through the dirt of Cheyenne. The effects can linger, says his stepmother, Donna: "The cleaners are always excited to get his pants."

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(Continued from page 117) In San Francisco I spend a lot of time in a stark room full of padded tables and tape. This is the home of a group of doctors and trainers called the Justin Sportsmedicine team.

Here a trainer named Rick Foster is helping bull rider Josh O'Byrne put on his knee braces. Josh is 33, old for this sport. A bald spot is growing under his hat, and there isn't much left of his knees. One of them dislocates frequently. "It ain't no fun when it comes out," he says with a shrug. Josh is close to the bubble and is determined to get on. "It's just an unreal feeling to be at the finals," he says.

"Try" is the cowboy's bottom line. It's the most important noun in the unique language spoken back of the chutes. It is effort, energy, and . . . heart.

From behind the chutes I often see how quickly a strong young man can be reduced to a dazed, staggering, bloody victim. A bareback rider named Alex Meroshnekoff, of Penngrove, California, goes romping off on a horse and comes back on a board, his back broken. Later, Toby Adams, a young bronc rider, is kicked square in the side of the head.

"Believers, I know what you're doing right now," Bob Tallman intones while Toby lies still. It looks as if someone had mopped his face with blood.

Back in Rick Foster's room, Toby is soon sitting up on a table, head bandaged, looking embarrassed that he can't remember much. Larry Sandvick, an irrepressible cowboy, sticks his head in the door: "Hey, Toby, you want me to sew you up?"

Toby can't remember the day of the week right now, but he knows Larry Sandvick, a top ten bareback rider who also runs a leather shop in Kaycee, Wyoming. A hideous image appears in Toby's mind: Larry approaching with a needle.

"No, Lar," Toby says.

"Bull riders are stupid," Larry once told me, then added, "bareback riders are stupid too, but they're more goofy."

Larry spends much of his time trying to prove at least the goofy part. Once, when he sliced a finger to the bone in his shop, he tried to sew himself up. One of his traveling partners, bareback rider Mark Garrett, was watching, and he got green quicker than Larry.

"Mark don't do blood too good," Larry said when he told me about it.

Mark Garrett is entered at the Cow Palace, but he isn't there. Later I hear the reason.

He and three other cowboys were flying in a single-engine plane from Bozeman, Montana, to the Cow Palace, when the engine quit, possibly out of gas. They crash-landed into trees.

Mark Garrett was sitting in the back of the six-seat plane. He was bruised and cut up but not broken. Everyone else was seriously injured. There was blood. Then there was fire.

Mark saw flames starting under the instrument panel, so the young man who didn't do blood too good scrambled out a door and started pulling out the others. With the help of another passenger, Scott Johnston, who had two broken vertebrae, Mark managed to get everyone out. The plane burned to ash.

The pilot died two weeks later, but the rest survived. It seemed to me that what Mark Garrett did could be called "try."

THERE IS ANOTHER SHADOW on rodeo. It is also the shadow of pain, but it's the pain of the one group of participants that cannot choose to avoid it—the animals.

"If people educated themselves about rodeo, they'd be horrified," says Peggy Larson, a veterinarian and former rodeo contestant.

Larson and others, including the Humane Society of the United States, oppose several rodeo practices. Among them are the use of the flank strap, a sheepskin-covered belt that is cinched around the lower abdomen of a horse or bull to encourage bucking. The flank strap does its job either because of a mild irritation like tickling, as rodeo people say, or, as some opponents say, because it causes "torment."

Rodeo opponents focus attacks on calf roping, in which a mounted cowboy chases a calf, ropes it, then ties it. "Calf roping is hell on wheels," says Larson. "What's making them run? Their tails are twisted, they're shocked with electric cattle prods, they're terrorized." When they're roped, she said, calves can have whiplash injuries or even broken necks.

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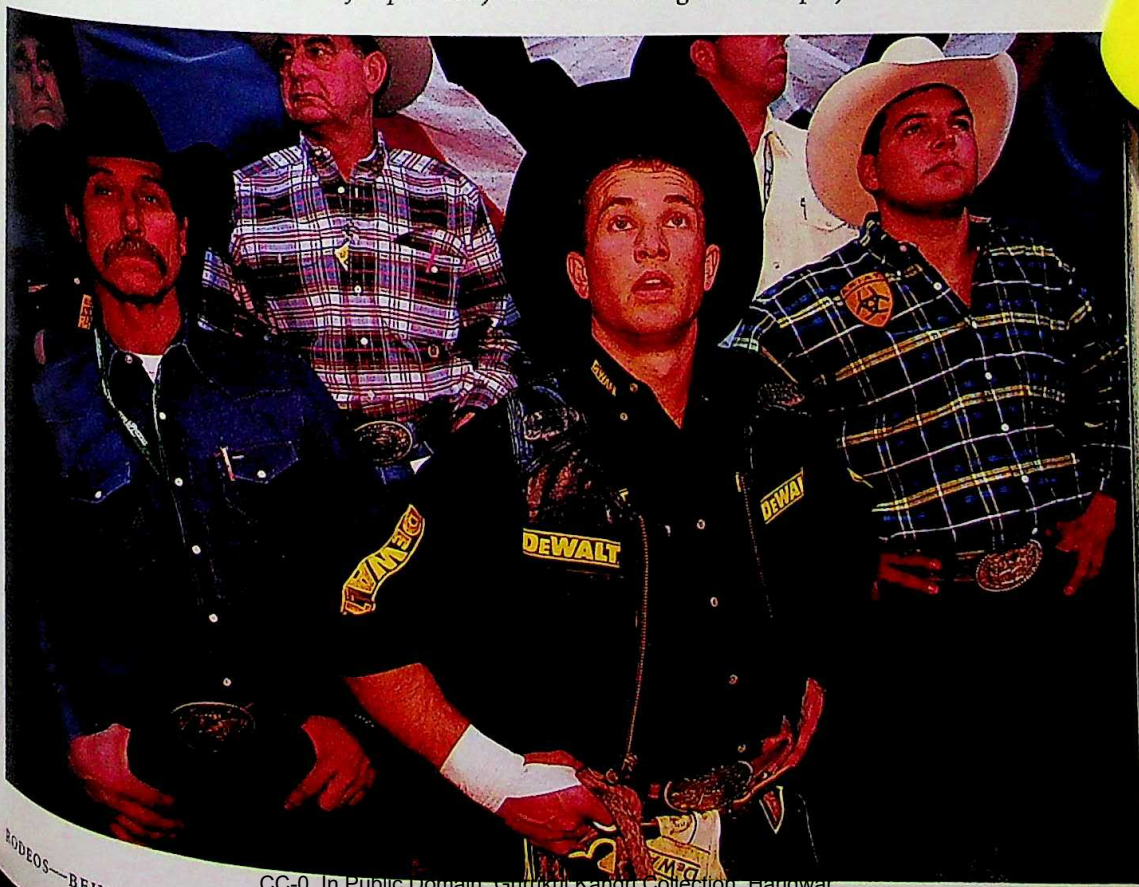
Rodeo's Super Bowl, the National Finals packs 'em in at Las Vegas. The event sells out 17,000 seats for ten straight nights. Behind the chutes former champ Bobby Brown (below, at left), bull rider Mike White, center, and calf roper Cody Ohl watch a big-screen replay.



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It glorifies youth and vigor, but it shatters them both. It is sentimental about its link with nature, its animals, but it's rough on them. Is that America?

In artificial mist at the finals, singer Shane McAnally lofts "The Star-Spangled Banner" into a patriotic hush. A horse pricks up its ears and awaits a cowboy's challenge. Though critics contend that rodeo is cruel, millions of fans are drawn to its simple drama of animal strength and human bravery.

The PRCA counters that its rules prevent most injuries and that things such as the flank strap just encourage animals to do what comes naturally—buck. Cowboys like to point out that the typical bucking bronc or bull is used in 20 to 30 rodeos a year and spends most of the rest of its life in pastures, making babies. This looks like a good life compared with that of many animals, including the millions of beef cattle that feed most of us.

From behind the chutes there seems no chance that this debate can be reconciled. I have seen animals (and a few rookie cowboys) that look desperate to escape the chutes, but I've also seen how sentimental both the cowboys and the owners are toward what they describe as the animal athletes they compete with and against; there were tears at the National Finals Rodeo when a famous bucking bull, Wolfman, was formally retired.

The question is simple: Is it civilized to make sport of animals' fear? Maybe not. But rodeo is not very civilized in general. As a throwback to the frontier, it's close to the moral equivalent of war in a negative as well as a positive way: All the drama and try of it depends on an inevitable—and unfair—cost to both the humans and the animals. There is no way to untie that knot.

BEHIND THE CHUTES Cody Custer squats on blue painted plywood, praying into his hat. This time he's not asking for a clear mind. He's praying for Josh O'Byrne, who's lying on the dirt on his back with his arms outstretched, not moving, while clowns dart in front of the bull.

"All you believers," says the booming voice of Bob Tallman on the loudspeakers, "I know what you're doing now."

Josh's fiancée climbs down the ladder from the stands onto the stage behind the chutes. "It's his wife, boys," somebody says, inaccurately. The crowd of men parts to let her get out to Josh.

It is the sixth day of the National Finals Rodeo. It has only been a few weeks since Josh told me how great it was to go to the finals. Now here he is, lying in the dirt.

Here in the glitter of Las Vegas, surrounded by the flags of sponsors that make the big prizes possible—Copenhagen Skoal, Crown Royal whisky, Coors ("The last real beer for the last real sport")—I'm suddenly angry at rodeo. I've seen one cowboy too many get hurt.

Is it as Tallman says? Does rodeo represent where we came from and what we are? Well, maybe. But if so, maybe that's not so great. This sport is a heap of contradictions. It claims to be moral, religious, conservative, but many of its boys run around cursing, picking up and discarding girls, getting drunk. It values freedom, but it's tied to the apron strings of sponsors like alcohol and tobacco. It glorifies youth and vigor, but it shatters them both. It is sentimental

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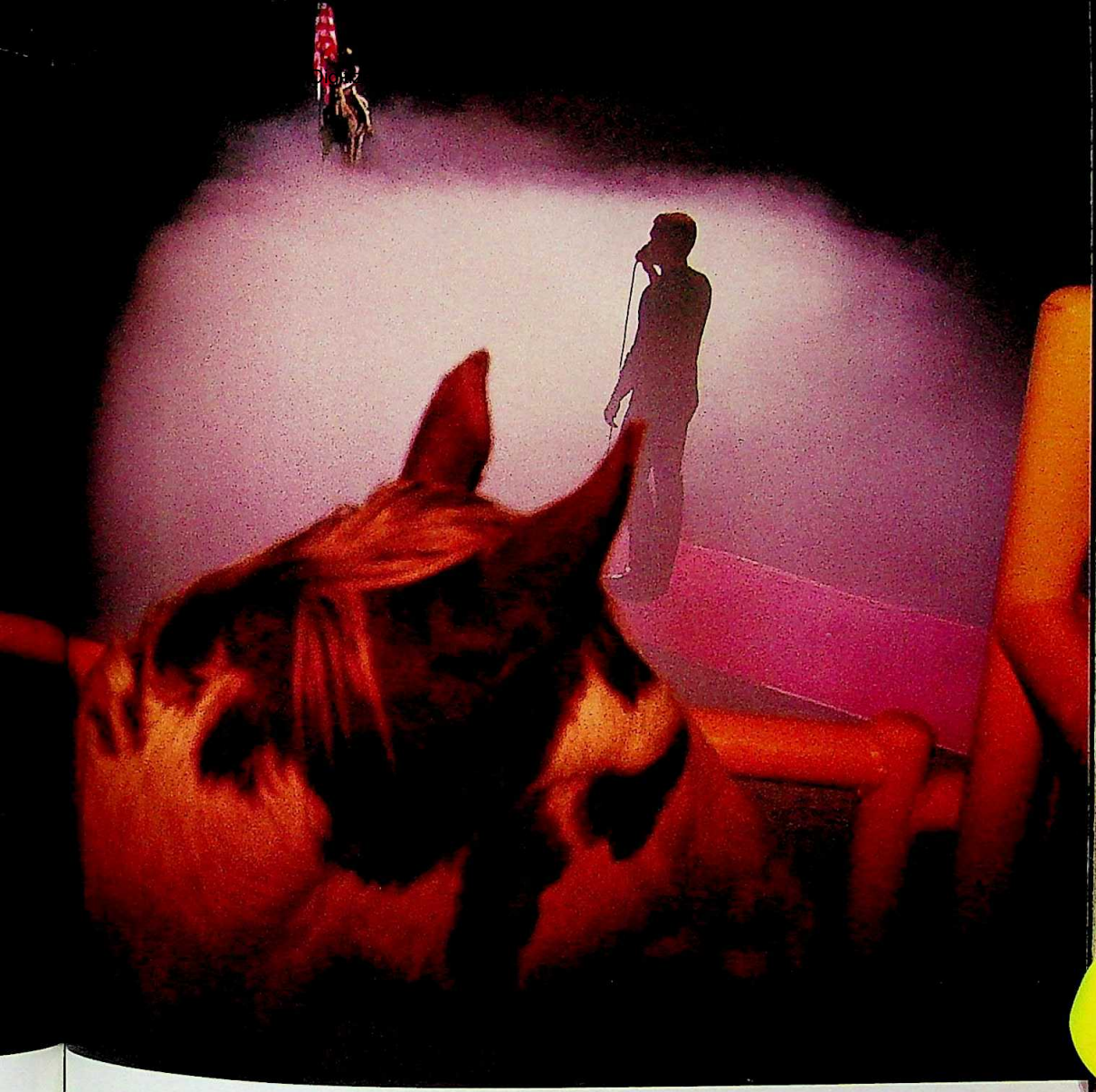

about its link with nature, its animals, but it's rough on them. Is that America?

As Josh is strapped to a board, I stand behind the chutes and wonder: If rodeo represents a national core of values, then what you find out here is that there is no excuse, no gentleness, no easy way out, and no escape from the rough edges of our past and the hard contradictions of our present.

But now they've got Josh off the dirt, and he sits up. Drops run off his nose—sweat or tears. His heart is broken because the concussion has ended his finals. But he'll be OK, and he'll get on again someday. My anger ebbs.

Back of the chutes there is one great moment left. It's Saturday night, and Sunday is the last performance. The tightest contest is in the bareback competition. Larry Sandvick, the goofy leather man, is in a virtual tie with a serious young rider named Mark Gomes. As I leave the chutes after the rodeo, Larry and Mark come booming out of the dressing room, arms on each other's shoulders, laughing.

"We're gonna fix it right now," Larry shouts. "We're gonna wrestle for it."

"When I win that belt buckle, Lar," Mark says, "I'll let you wear it."

This is the moment I will remember about rodeo: Two young superstars kidding each other in the echoing concrete hall back of the chutes, knowing that what they share matters more than what they're fighting over.

Larry and Mark lope off down the hall together, still laughing, like a couple of kids just running through the rain. □

Cowboy romance or animal exploitation—what's your opinion of rodeo? Share your thoughts online at *www.nationalgeographic.com/ngm/9909.*

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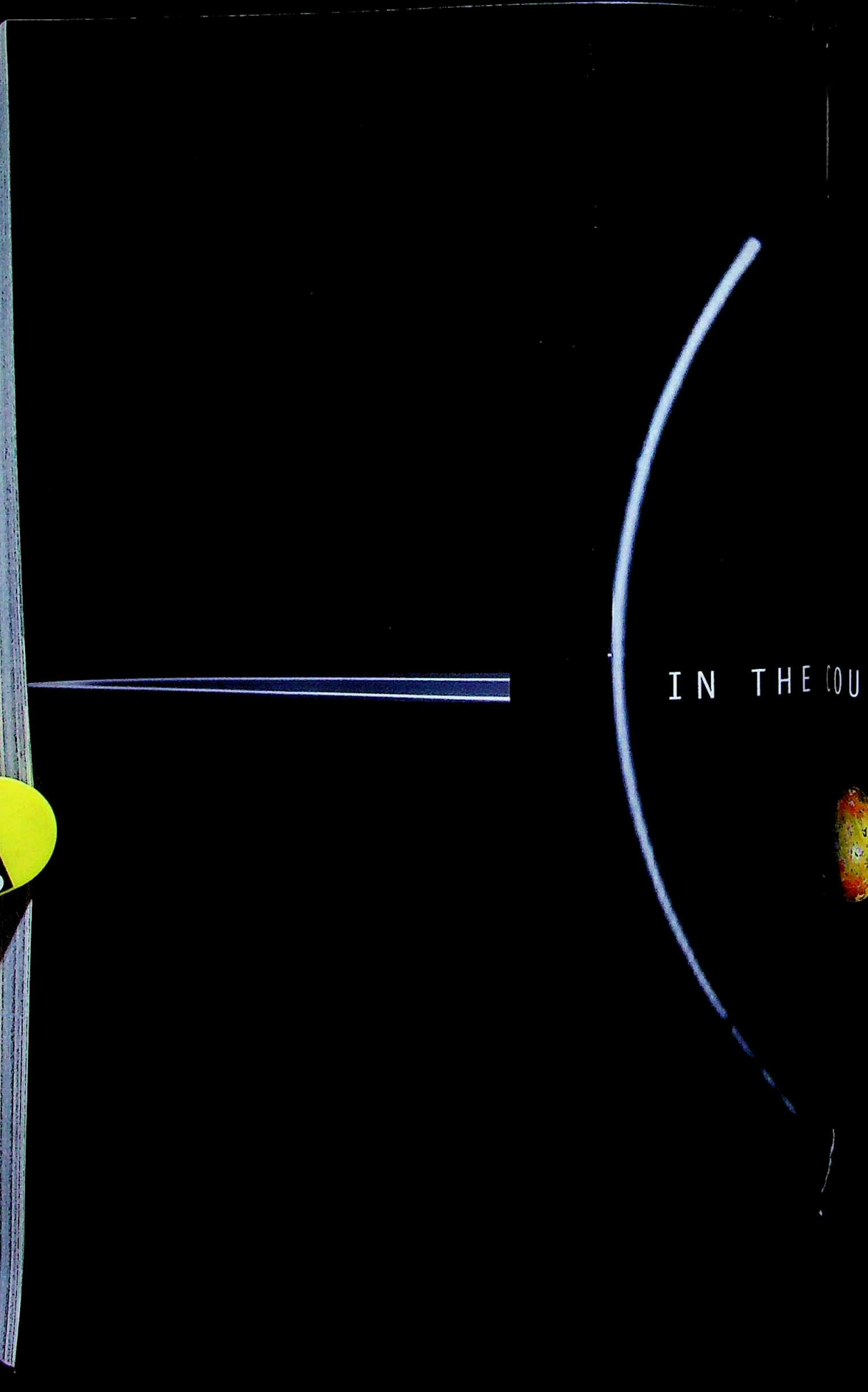
IN THE COU

THE COURT OF KING JUPITER

LIT FROM BEHIND BY THE SUN, JUPITER'S RING SYSTEM WAS DISCOVERED IN 1979 DURING THE VOYAGER FLYBYS. NASA'S GALILEO ARRIVED 16 YEARS LATER TO LINGER WITH THE KING OF PLANETS AND SCOUT ITS LARGEST MOONS, SHOWN HERE IN A COLOR-ENHANCED COMPOSITE: IO, EUROPA, GANYMEDE, AND CALLISTO.

BY WILLIAM R. NEWCOTT
NATIONAL GEOGRAPHIC SENIOR STAFF

CORNELL UNIVERSITY AND NASA; MOONS BY DEUTSCHES ZENTRUM FUR LUFT UND RAUMFAHRT (DLR) AND NASA

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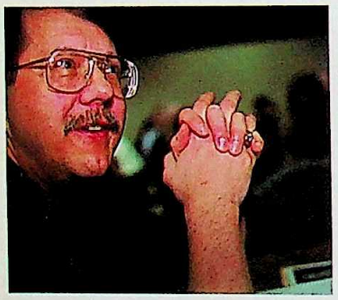
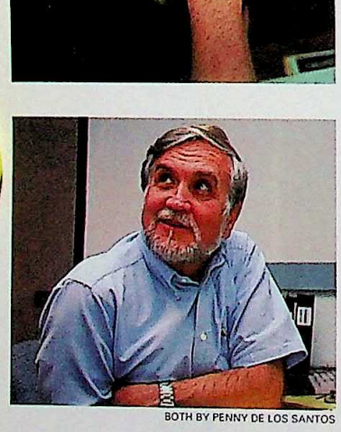
TORRENCE JOHNSON'S CAMERA was halfway to Jupiter when he discovered that, in effect, he'd be getting back only one roll of film. The Galileo spacecraft, launched a decade ago this October by NASA's Jet Propulsion Laboratory (JPL), was supposed to take more than 50,000 images during its voyage to Jupiter and its moons. But Galileo's umbrella-like high-gain antenna failed to open en route, and without it the craft would have to transmit those images back to Earth, 470 million miles away, through an antenna the size of a coffee can. "It appeared," said Johnson (below, top), the Galileo project scientist, "that instead of the 134,000 bits per second in telemetry we'd expected to receive from Galileo, we'd end up with ten. We'd be lucky to get a handful of images." At a cost of 1.4 billion dollars, those pictures had better be good.

Galileo's problem most likely arose as it awaited the beginning of its mission. The craft was supposed to be launched from a space shuttle in 1982, but shuttle-design troubles and the *Challenger* accident pushed the date back to October 1989. "It's possible that during storage and transport the lubricant on the high-gain antenna was rubbed off," said Johnson. "When we finally tried to open it, it got stuck."





BOTH BY PENNY DE LOS SANTOS

With only the smaller antenna operating, JPL scientists were faced with a problem akin to funneling a Niagara Falls of data through a garden hose. The spacecraft's 18 computers had less memory than a cheap laptop today. So for two years, while Galileo completed its cruise to Jupiter, JPL engineers created data-compression programs and transmitted them to the craft.

"Galileo's computers may have been old, but they were also flexible—designed so they could be reprogrammed from Earth. That's what saved us," says Ronald Greeley (left), a planetary geologist and imaging-team member from Arizona State University. "But until those images started coming back, it was nail-biting time."

By the time Galileo arrived in 1995 and began its gravity-driven tour of Jupiter's moons, "we were getting about 1,000 bits of data per second," Johnson says. "It's not 134,000, but it's decent." So far, Galileo has provided more than 2,000 images from the Jupiter system—"a fantastic success in the opinion of the whole scientific community," says Johnson. As a bonus, Galileo's ancient computers are immune to the infamous Y2K bug, which threatens to shut down many computers on January 1, 2000. Why? "Our computers," Johnson says, "don't use dates. They use a simple counter."

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JUPITER

SKIRTING THE FACE OF THE GIANT GAS PLANET, GALILEO FOUND A STRATIFIED KALEIDOSCOPE OF SWIRLING, COLORFUL CLOUD FORMATIONS, TOWERING THUNDERSTORMS, AND SHIMMERING AURORAS.

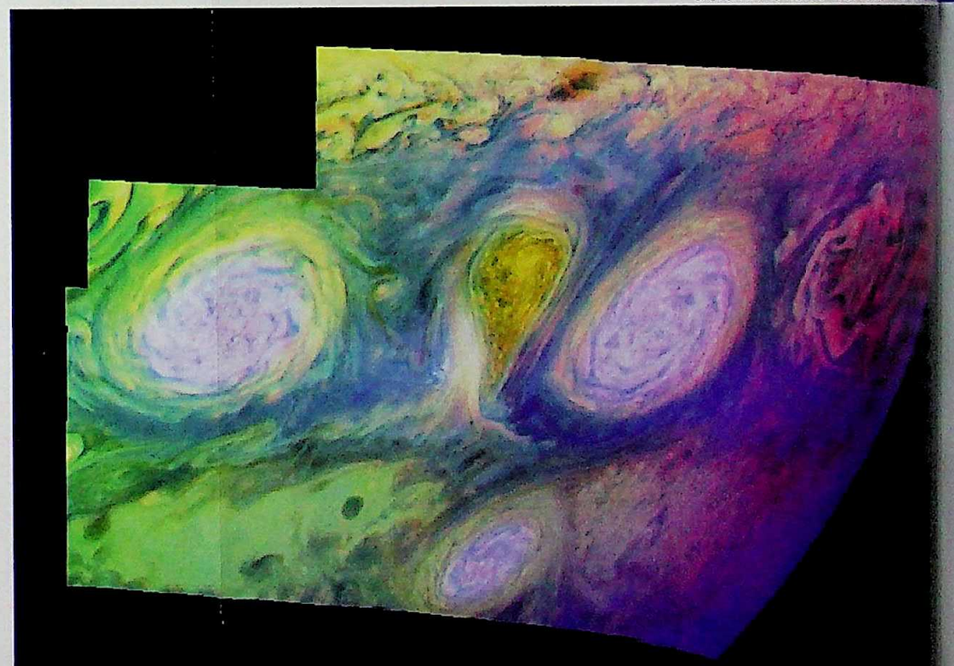
A night-sky standout, Jupiter became the first planet beyond our own to be explored through a telescope when it was observed in 1610 by Galileo Galilei. For more than 300 years scientists have studied Jupiter's enormous Great Red Spot, a churning storm that still shows no sign of letting up.

Smaller anticyclones, identified as Jupiter's White Ovals, have been seen since the 1930s—and after its arrival Galileo sent back an image of two of them drifting tantalizingly close to each other (upper image below).

"It became clear they would merge," said Johnson. "And when we imaged them again in September 1998 [lower], the two White Ovals had become one. We caught one of the first major changes in Jupiter's atmosphere in more than 60 years."

Near Jupiter's north pole Galileo detected the thin arc of an aurora (top right) glowing in the night. Jovian auroras have the same causes as those on Earth: Electrically charged

CALIFORNIA INSTITUTE OF TECHNOLOGY AND NASA



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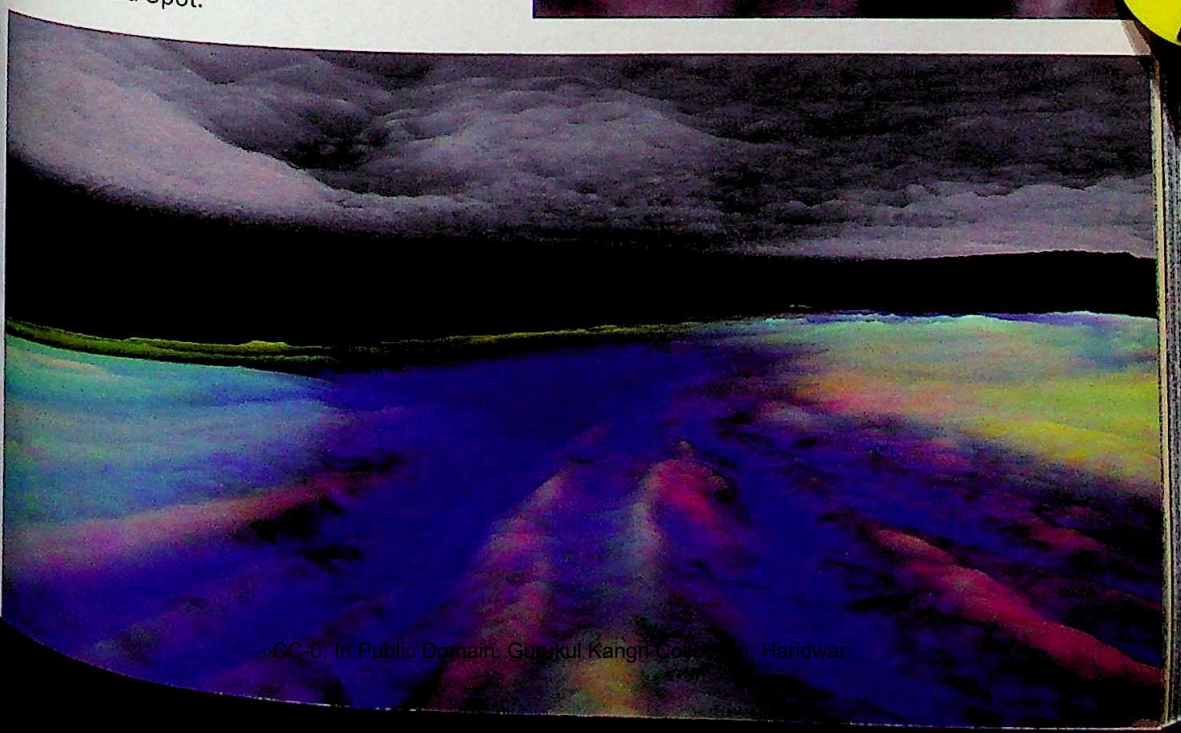
CORNELL UNIVERSITY, CALIFORNIA INSTITUTE OF TECHNOLOGY, AND NASA (MIDDLE); CALIFORNIA INSTITUTE OF TECHNOLOGY AND NASA

particles traveling along the planet's magnetic field lines strike the upper atmosphere and make hydrogen gas glow some 155 miles above Jupiter's cloud tops.

Computer imaging creates a false-color glimpse between two cloud layers (below) just north of Jupiter's equator. Dark blue indicates an area largely clear of clouds, where dry air descends deeper into the atmosphere. Ammonia ice crystals form the upper haze; its distance above the lower clouds is exaggerated in the image. Galileo also captured a convective thunderstorm (right) northwest of the Great Red Spot.



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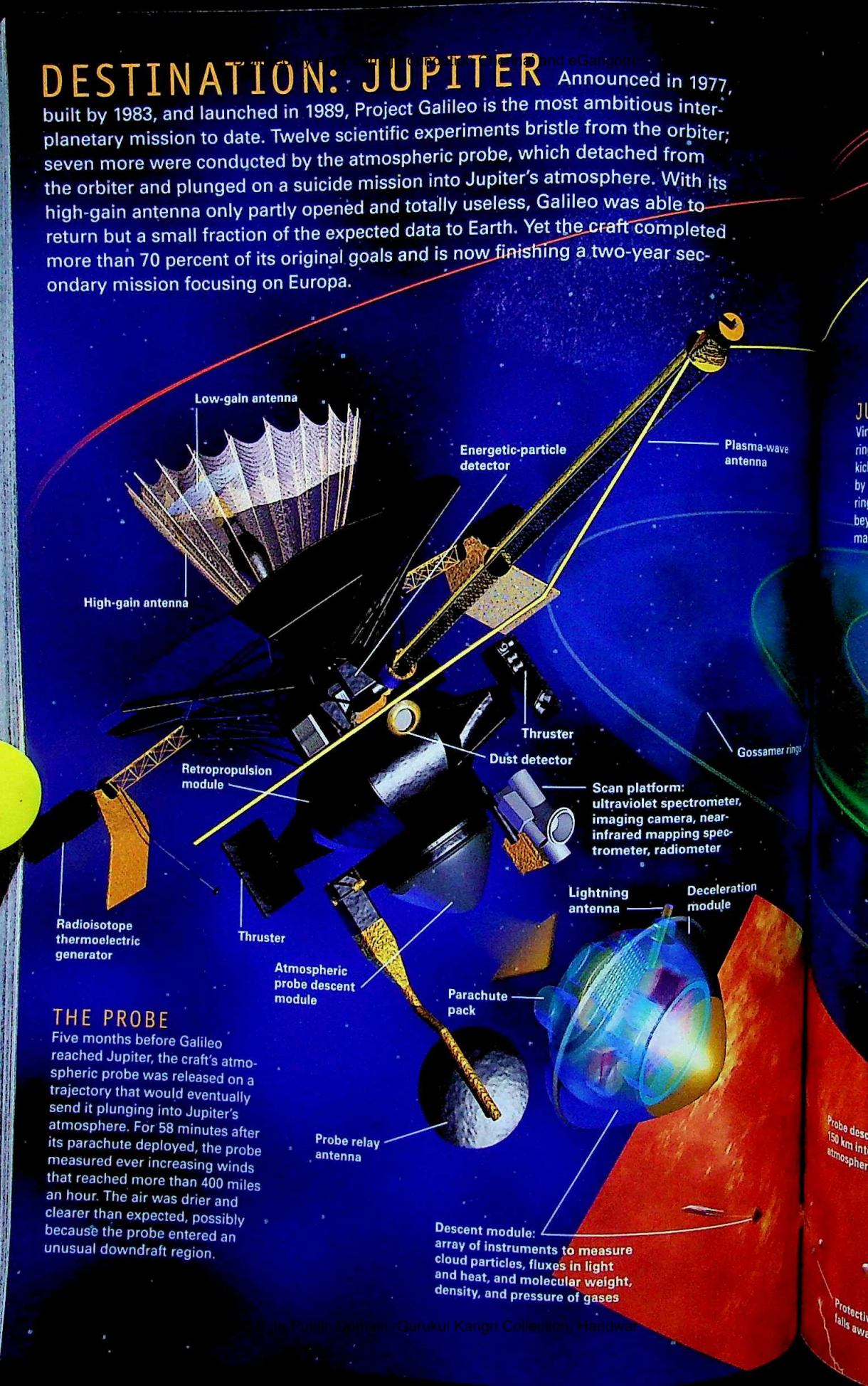
DESTINATION: JUPITER

Announced in 1977, built by 1983, and launched in 1989, Project Galileo is the most ambitious interplanetary mission to date. Twelve scientific experiments bristle from the orbiter; seven more were conducted by the atmospheric probe, which detached from the orbiter and plunged on a suicide mission into Jupiter's atmosphere. With its high-gain antenna only partly opened and totally useless, Galileo was able to return but a small fraction of the expected data to Earth. Yet the craft completed more than 70 percent of its original goals and is now finishing a two-year secondary mission focusing on Europa.



THE PROBE

Five months before Galileo reached Jupiter, the craft's atmospheric probe was released on a trajectory that would eventually send it plunging into Jupiter's atmosphere. For 58 minutes after its parachute deployed, the probe measured ever increasing winds that reached more than 400 miles an hour. The air was drier and clearer than expected, possibly because the probe entered an unusual downdraft region.

GETTING THERE

To save fuel, Galileo took the long way to Jupiter, getting gravity assists from Earth and Venus to slingshot it to the outer solar system. The craft flew past Earth and through the asteroid belt twice before reaching Jupiter.

JUPITER'S RINGS

Virtually invisible from Earth, the rings of Jupiter are made of dust kicked off the planet's inner moons by meteoroids. The closest of the rings is a doughnut-shaped halo; beyond that are a bright, flattened main ring and two diffuse rings.

ANATOMY OF A GIANT

Like the sun, Jupiter is mostly hydrogen and helium. Surrounding Jupiter's core, most likely molten rock, is a deep layer of liquid metallic hydrogen, created by intense pressure. It is covered by a layer of mainly hydrogen gas, an inner cloud layer of water, clouds of ammonium hydrosulfide, and finally a haze of ammonia ice.

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ART BY PETER BOLLINGER

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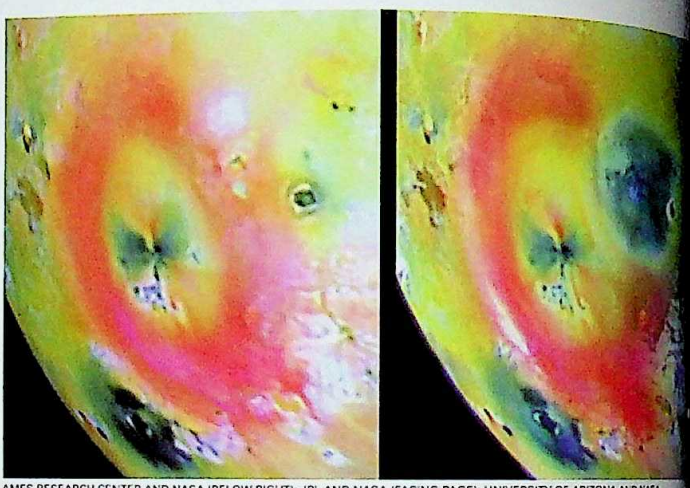
IO

THE MOST VOLCANIC BODY IN THE SOLAR SYSTEM, ROCKY IO IS TORTURED BY JUPITER'S MIGHTY GRAVITATIONAL PULL. WITH A SOLID SURFACE THAT RISES AND FALLS IN 300-FOOT TIDES, IO CHANGES ITS FACE DAILY WITH NEW ERUPTIONS OF GAS AND SUPERHEATED LAVA.



AMES RESEARCH CENTER AND NASA (BELOW RIGHT); JPL AND NASA (FACING PAGE); UNIVERSITY OF ARIZONA AND NASA

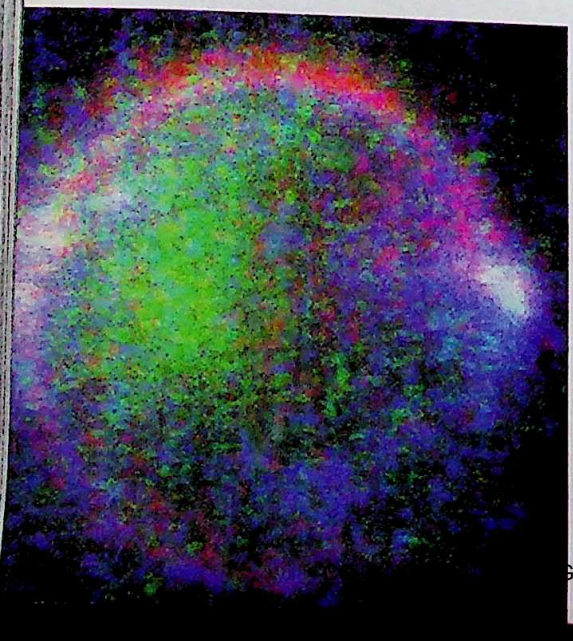
Between April 4, 1997 (near right), and September 19, 1997 (far right), an area on Io roughly the size of Arizona was buried beneath a dark smudge of volcanic debris. A volcano called Pillan Patera had exploded, throwing hot sulfur and rock ash in an 87-mile-high plume, seen on Io's edge in another view (facing page). This view also shows a plume rising from a volcano called Prometheus, visible at Io's equator near the moon's nightside. Prometheus remains as active as it was 20 years ago, when Voyager I sent back the first images of an active volcano beyond Earth. The dark shape extending to Prometheus's right is the shadow of the plume cast by the sun.

Like a blast furnace at night, Io (below left) glows with gases released by volcanic activity. Charged particles from Jupiter's magnetic field collide with the gases, causing them to glow in colors that identify their composition: Sulfur dioxide shines white, oxygen red. Green areas may be oxygen and sodium.

"Some of the lavas erupting on Io are extremely hot, as high as 3140°F," says planetary geologist Alfred McEwen. "That's much hotter than present-day eruptions on Earth but similar to lava that commonly erupted on Earth in the early Precambrian period. The tidal forces of Jupiter melt Io's interior, creating a very high heat flow."

Adds Johnson: "So when we look at Io, we're looking at a place that is in some ways a lot like Earth was long ago."

Passing across the face of Jupiter (below right), rocky Io floats in sharp contrast to its gassy parent.



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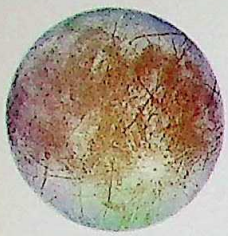
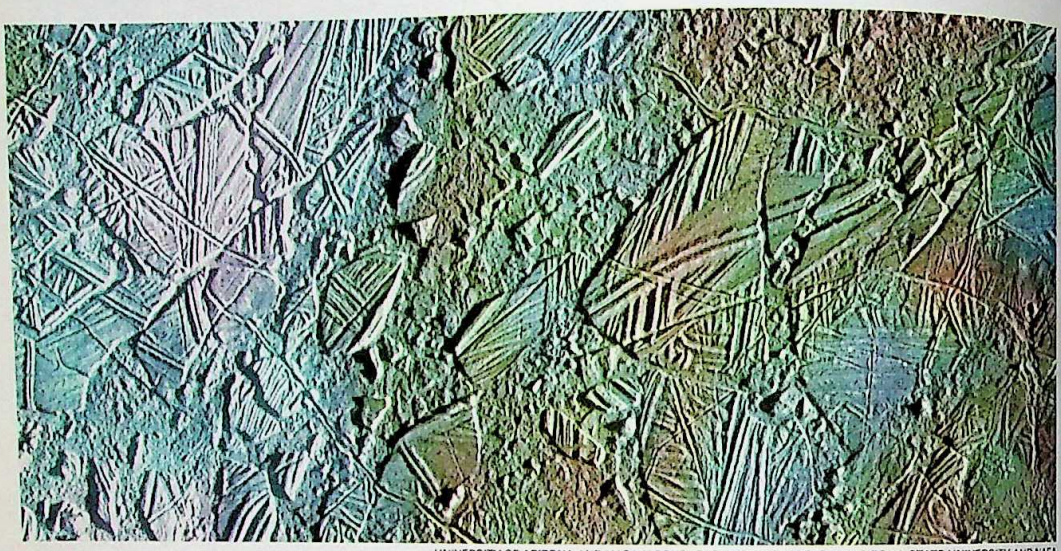


EUROPA

TAKE EARTH'S MOON AND COVER IT WITH A HUNDRED-MILE-THICK SHELL OF WATER—SOME OR ALL OF IT FROZEN. THAT'S EUROPA, A CRACKED ICY CUE BALL THAT IS ABOUT TO BECOME A FOCUS OF THE SEARCH FOR LIFE BEYOND EARTH.



UNIVERSITY OF ARIZONA AND NASA (ABOVE); DLR AND NASA (BELOW); ARIZONA STATE UNIVERSITY AND NASA

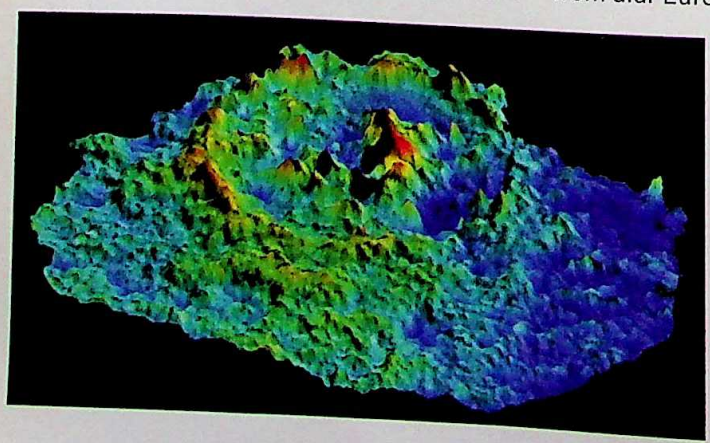
To understand scientists' fascination with Europa, you need to know just one fact: Europa holds more water—possibly liquid water—than all the oceans on Earth.

"Water is very common in the outer solar system," says Greeley. "That's just the way elements are distributed."

But on Europa the tidal forces of Jupiter's gravity generate heat that may keep water beneath its icy crust from freezing. The heat drives subcrustal convection, which fractures the surface of the moon, creating intricate patterns of ridged ice "rafts" (above). The brown color indicates the presence of mineral contaminants spread by water vapor released from below. To the left, white and blue ice crystals have been scattered across the surface, probably from the impact that created the crater Pwyll, 620 miles to the south. Such impacts may have delivered organic compounds to Europa.

A computer-generated image of Pwyll (below) shows a typical impact crater, but the crater floor is at the same level as the surrounding terrain—suggesting that it was filled from below with water seeking its own level.

Despite its fractured features (facing page), from afar Europa appears remarkably smooth. No surface features measure more than a few hundred feet high, evidence that the ice sheet is in fact reshaping itself.



"Life as we know it requires heat, liquid water, and organic compounds," says Greeley. "Europa appears to have all three." And that is why NASA's next Jupiter mission will head straight for Europa and stay there.

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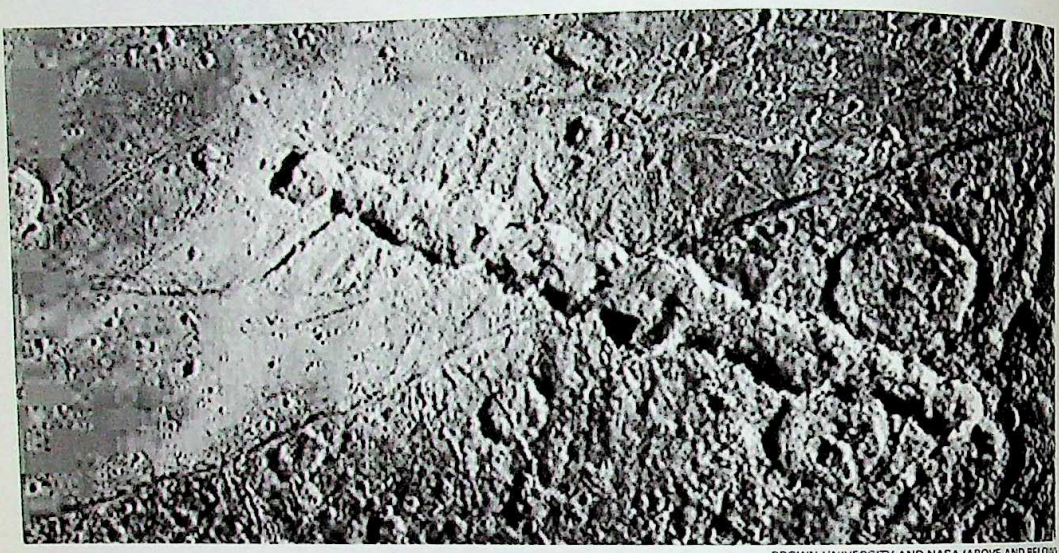
GANYMEDE

THE SOLAR SYSTEM'S LARGEST MOON IS BIGGER THAN MERCURY, PULSATES WITH ITS OWN MAGNETIC FIELD, AND MAY HAVE ONCE ERUPTED WITH VOLCANOES OF ICE OR WATER.



BROWN UNIVERSITY AND NASA (ABOVE AND BELOW)

Swooping within 519 miles of the largest moon of the largest planet, the Galileo spacecraft made an unexpected discovery: Ganymede has its own magnetosphere. Nowhere else in the solar system had scientists found a moon with a stable, internally generated magnetic field.

"So what we have is this little magnetosphere operating inside Jupiter's much larger magnetosphere," says Johnson. Most scientists thought Ganymede would be too cold to have a molten iron core capable of generating such a field. But the moon's orbit may have been altered in the recent past, subjecting it to stronger tidal forces that liquefied and stirred up its iron core. "It is likely," says Johnson, "that a molten core is generating the magnetic field today."

Ganymede has two types of terrain: older, dark, crater-beaten areas and newer, bright, ice-rich areas that have torn apart and replaced the older surface. A region containing both types is slashed by a diagonal chain of 13 craters (above), caused by the low-angle impacts of pieces from a comet.

In its warmer past Ganymede's surface may have surged with volcanoes not of rocky lava but of ice or water. Such eruptions could have sculpted channels (below) into the terrain.

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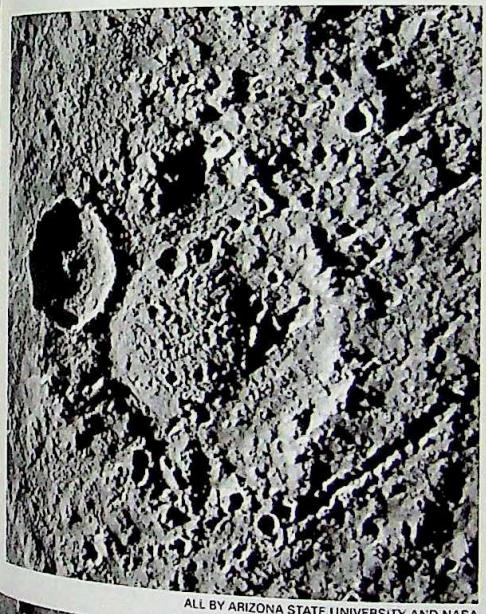
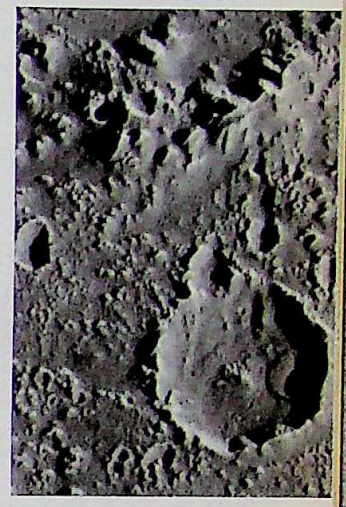
CALLISTO

SOMETHING IS EATING AWAY AT THE SURFACE OF JUPITER'S MOST DISTANT MAJOR MOON, BUT EVEN MORE MYSTERIOUS IS WHAT MAY LIE BENEATH ITS CRATERED FACE: AN OCEAN OF SALTY WATER.

Judging from Voyager images, scientists expected to find craters of every size on shell-shocked Callisto, from giant bull's-eyes to tiny pockmarks. "But what we saw," says Greeley, "was an eroded surface with very few craters smaller than a half mile. The surface is being eaten away and blanketed by soft, fluffy stuff."

At the upper rim of an impact crater (right) a section has given way in a landslide. The distance traveled by the debris—nearly two miles—suggests a loose, fine-grained surface. An older, eroded crater called Har (left) has a large, rounded mound on its floor that was probably caused by upwelling ice. Ice may play a key role in smoothing Callisto's surface. A highly detailed view taken in the moon's largest impact structure, Valhalla (below)—marked by a shadow from a fault scarp—shows a blanket of fine debris.

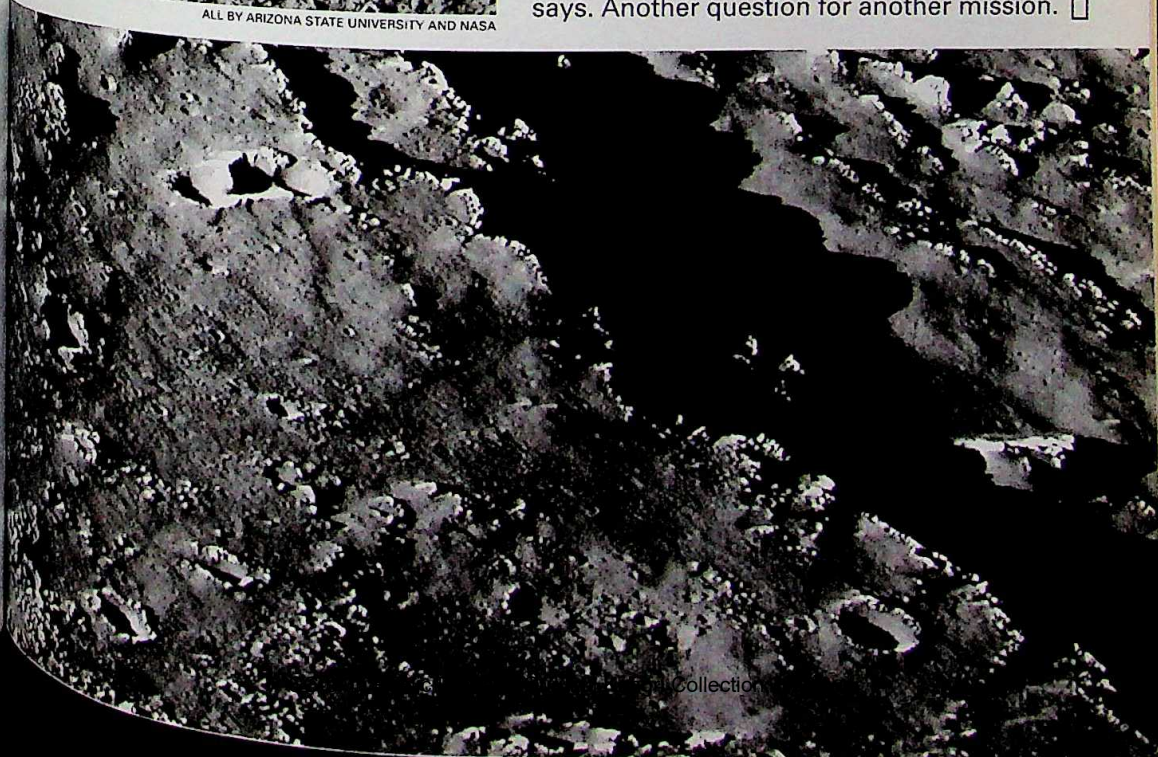




ALL BY ARIZONA STATE UNIVERSITY AND NASA

"As the ice sublimates and is lost, all that is left is the dirt," says Greeley. "It's like after your snowman melts, and all that's left is that little pile of soil."

But why here on Callisto and not on heavily cratered Ganymede? "Who knows?" Greeley says. Another question for another mission. □



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VITTORIO SELLA

■ FROM THE GEOGRAPHIC ARCHIVES

Kashmir's Floating Assets

"A large part of the population of Srinagar lives afloat," wrote Florence H. Morden in our October 1929 article "House-Boat Days in the Vale of Kashmir," for which this photograph—never before published in the magazine—may have been purchased. "The best are comfortable and well-furnished houseboats, such as one might see upon the River Thames."

For this article Morden spent a summer on a craft called the *Melisande*, but she seemed more interested in shopping opportunities than geography. "The native industries of Kashmir, alas, have cheapened and some have almost died out entirely," she wrote. "No longer, for instance, can one procure the very finest shawls, such as made the name of Kashmir famed throughout the world. One can get good shawls, soft and fine, but the exquisite, old-time shawls are hardly to be found outside of museums."

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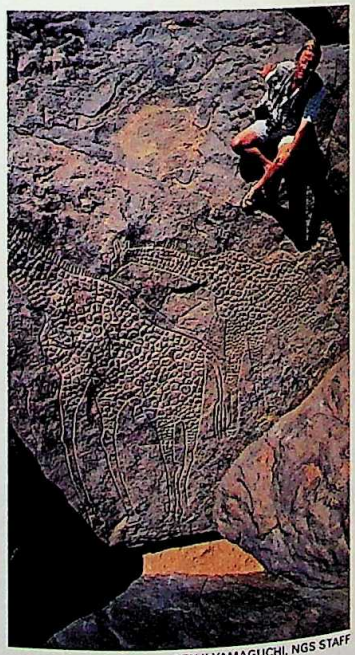
DAVID COULSON

Improvising in the Sahara

In the 16 years I've worked as a photographic technician at National Geographic, I have engineered numerous remote-controlled shots. In Greenwich, England, and Machu Picchu, Peru, I rigged cameras from small, tethered helium balloons without any problems. But when I went to Niger to make aerial photographs of 7,000-year-old rock art in the Sahara, my luck ran out: The tether broke—fortunately, before I installed the camera. As a substitute I rigged a tripod of 26-foot-long steel rods. Local Tuareg assistants held the swaying contraption in place (above). As I viewed the scene through a hand-held video monitor, author-photographer David Coulson (right) helped position the camera from below. To change the lens or exposure, we had to take down the tripod and then set it up again—dozens of times in 110° heat. It was my hardest assignment, but the result was the photograph that appears on pages 88-9.

—KENJI YAMAGUCHI



KENJI YAMAGUCHI, NGS STAFF

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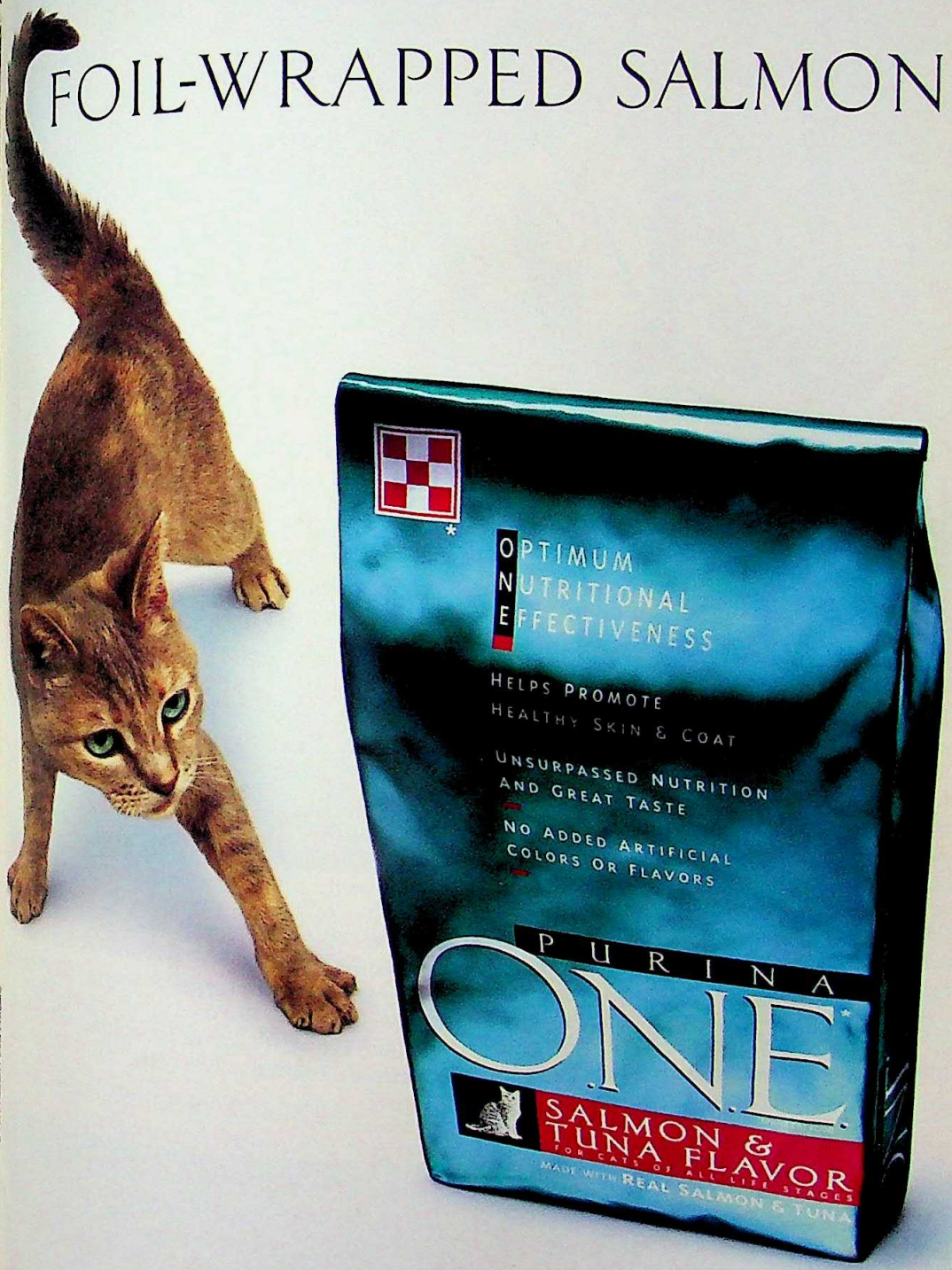
LIKE A TIGER IN THE NIGHT

SHE STALKED THE FOIL-WRAPPED SALMON



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Behind the Scenes

Writing & Writing

A Man of Letters

Last month's GEOGRAPHIC story on writing needed a little something extra—more writing! We called on Julian Waters, master calligrapher. A longtime freelance contributor—his work has embellished subjects from Lewis Carroll to Native Americans for this magazine—Julian has also designed lettering for children's books, for stamps for the U.S. Postal Service, and for the Women in Military Service for America Memorial in Arlington, Virginia.

Before deciding on the lettering for a magazine article, Julian looks over the entire package of the text and photographic layout. "Calligraphy can make or break a page's graphic design," he says. He then crafts his own style of hand lettering to suit the needs of the page; some of his "roughs" for the writing story title appear above.

Though he specializes in adding the human touch of calligraphy to graphic design, Julian is just as comfortable in the digital arena as he is with his traditional pens and brushes. He created a popular computer typeface family, Waters Titling MM, which was also used in the design of last month's story. It's almost as beautiful as if he had written it himself.

NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THIESSEN

The Will to Surprise

He worked as a maintenance man, lived in a ramshackle house, and dressed from thrift stores. He loved collies, watercolor painting, ballroom dancing—and the NATIONAL GEOGRAPHIC. When Karl H. Hagen, an 89-year-old native of Suitland, Maryland, died in March, he bequeathed a million dollars to the Society.

Robert S. Herman, 84, of Melbourne, Florida, had the same idea. When he asked neighbor Don Paterson to help him make a will, they bought a kit. "What are your total assets?" Don asked. "Five million dollars," Bob replied. A lawyer was enlisted. Bob died in February; his million-dollar gift will endow a fund for the Committee for Research and Exploration. Bob Herman—a lifelong traveler—would have liked that.

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Japanese Murrelet *(Synthliboramphus wumizusume)* **Size:** Length, 24 cm **Weight:** Average, 164 g **Habitat:** Breeds on small islands off the coasts of Japan and South Korea; winters offshore of breeding sites and in waters north to the Kuril Islands **Surviving number:** Estimated at 5,000-6,000 Photographed by Koji Ono

WILDLIFE AS CANON SEES IT

Long black crown feathers form the distinctive crest of a Japanese murrelet in summer plumage. Nesting in cracks and holes in rocks, the little seabird lays two eggs, usually a week apart, and for a month the murrelet pair shares two-day incubation shifts. The newly hatched, down-covered chicks remain in the nest for only a day or two, without being fed, before the parents lead their tiny fledglings out to sea after dark.

Japanese murrelet colonies are small, and most vulnerable during breeding season. Introduced species such as rats and rabbits have degraded murrelet populations, and crow predation poses a growing threat. As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.

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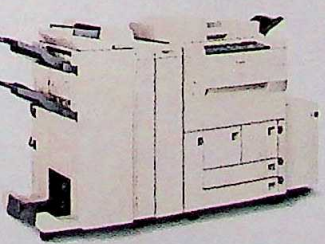

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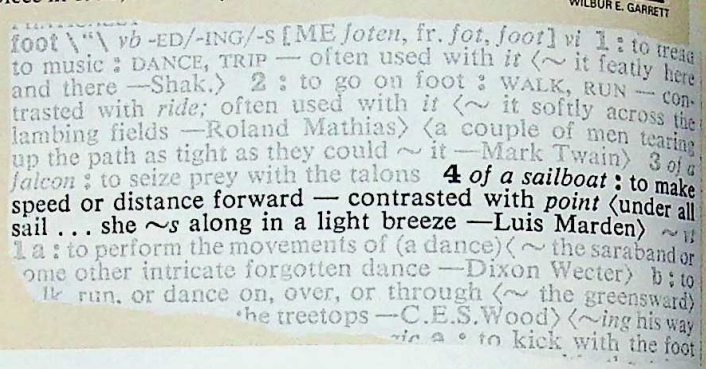
Look Him Up; He's in the Book

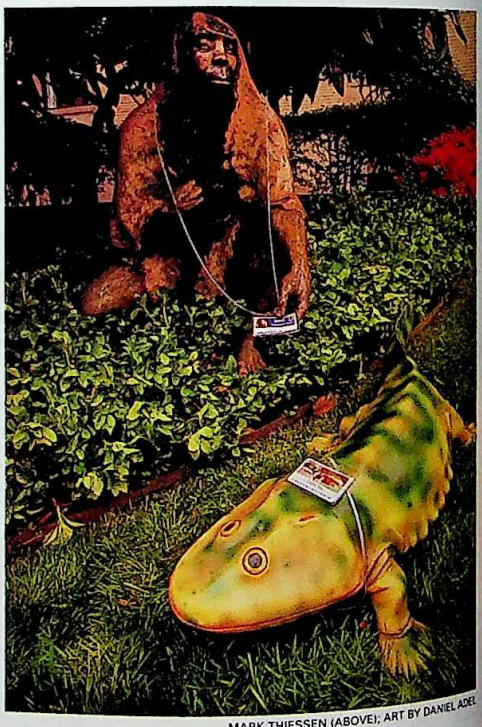
WILBUR E. GARRETT

Call them Luis Marden's defining moments: The GEOGRAPHIC veteran—who spent 43 years as a staff writer and photographer and contributed his latest magazine piece in 1998, some 22 years after retirement—is quoted six times in *Webster's Third New International Dictionary*. His citations appear in the definitions of the following words: foot (right); snick, a clicking noise; tot, a small amount of an alcoholic beverage; unstep, to remove a ship's mast; warp, to haul a ship with a rope; and sevillana, a Spanish dance.


foot \"\ *vb* -ED/-ING/-S [ME *foten*, fr. *fot*, *foot*] *vi* **1** : to tread to music : DANCE, TRIP — often used with *it* ⟨~ it featly here and there —Shak.⟩ **2** : to go on foot : WALK, RUN — contrasted with *ride;* often used with *it* ⟨~ it softly across the lambing fields —Roland Mathias⟩ ⟨a couple of men tearing up the path as tight as they could ~ it —Mark Twain⟩ **3** *of a falcon* : to seize prey with the talons **4** *of a sailboat* : to make speed or distance forward — contrasted with *point* ⟨under all sail . . . she ~*s* along in a light breeze —Luis Marden⟩ ~ *vt* **1 a** : to perform the movements of (a dance) ⟨~ the saraband or some other intricate forgotten dance —Dixon Wecter⟩ **b** : to run, or dance on, over, or through ⟨~ the greensward⟩ ⟨~ the treetops —C.E.S.Wood⟩ ⟨~*ing* his way ... to kick with the foot

Objects of Our Affection

They don't move much, but they work here; just check their ID badges. Staff member Thog (right, at top) started his career in an exhibit on early humans in Explorers Hall. He then did a stint in the President's office as the Society's unofficial mascot, occasionally modeling seasonal garb and proffering mail in his outstretched hand. Today Thog operates out of Associate Editor Bob Poole's office. Eddie Too, a 380-million-year-old tetrapod, at bottom, was commissioned by photographer Jonathan Blair for our May 1999 story "The Rise of Life on Earth." Now a contract employee, Eddie makes his home next to Editor Bill Allen's desk.


MARK THIESSEN (ABOVE); ART BY DANIEL ADEL

The Tie That Binds Him

"Ties cut off air to my brain," says photographer Nick Nichols. "I only wear one when I feel it's absolutely necessary." Nick has spoken before presidents in appropriate neckwear but was turned away—in a designer T-shirt and jacket—from his own presentation at London's posh Royal Automobile Club recently. Staffer Eddie Dornack rushed to buy him a collared shirt and tie. "I made sure they were nice," says Eddie. "I knew I'd get to keep them when it was over."

TEXT BY MAGGIE ZACKOWITZ

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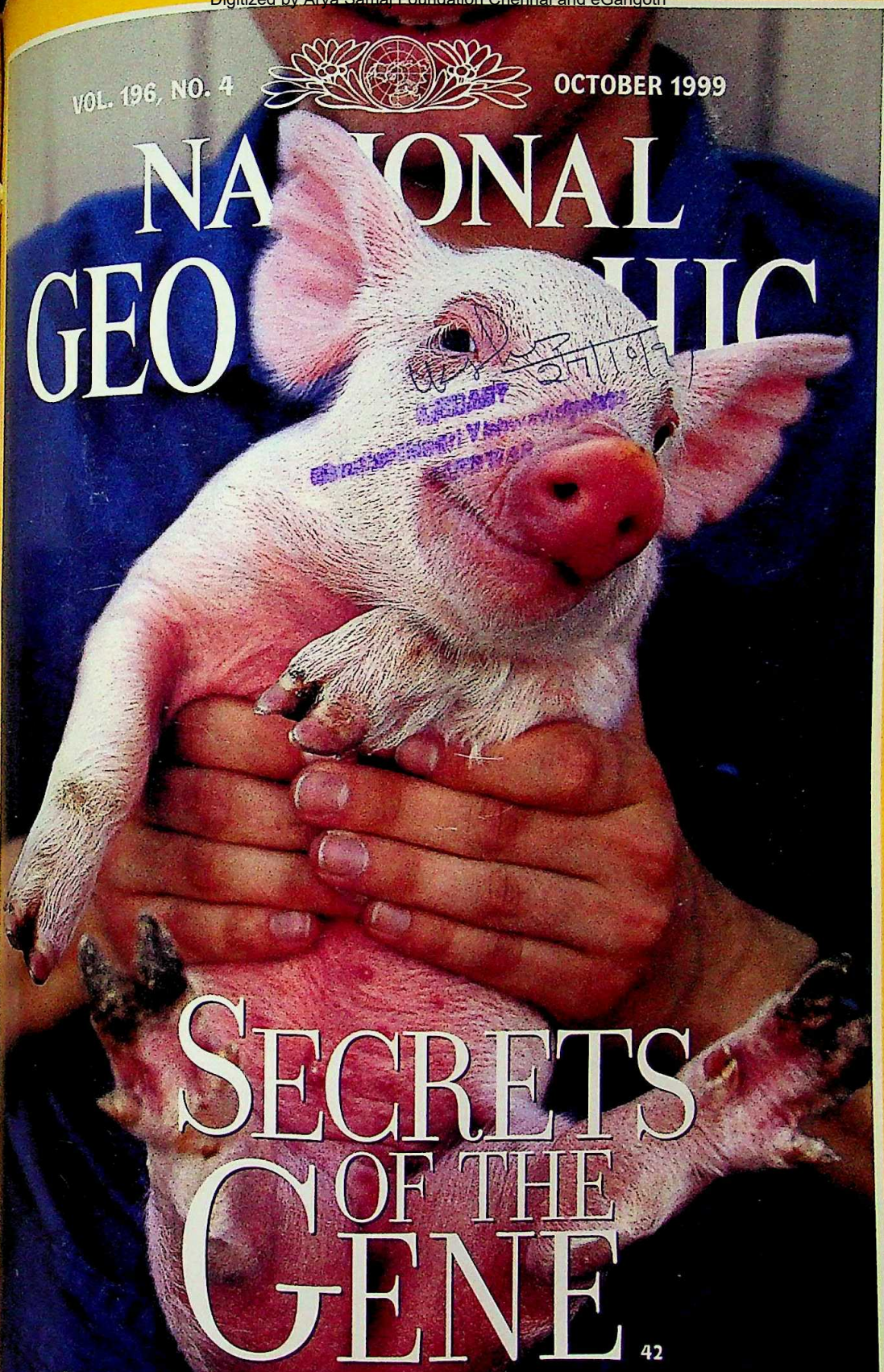

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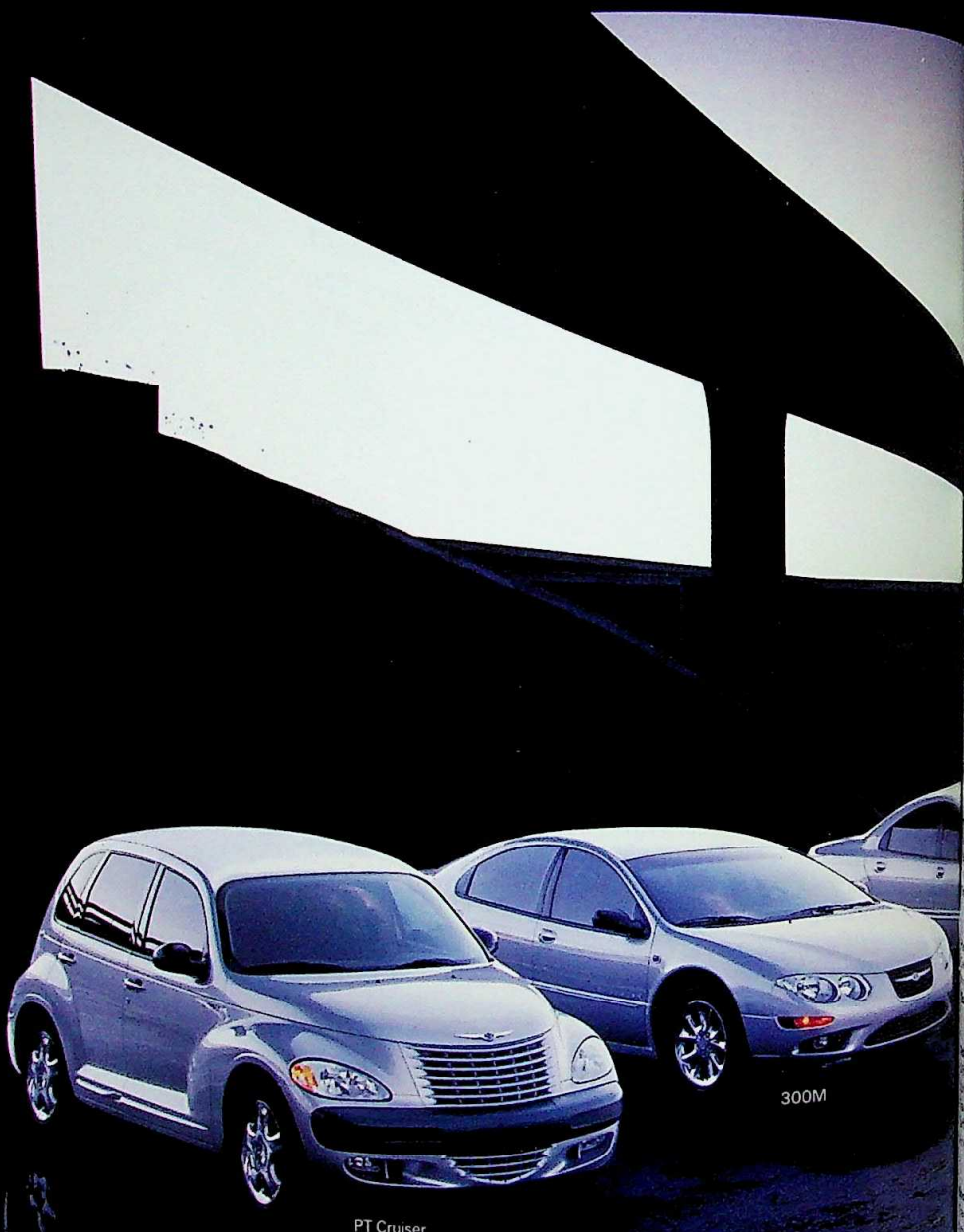
Without a soul, there's just a shell. Wi



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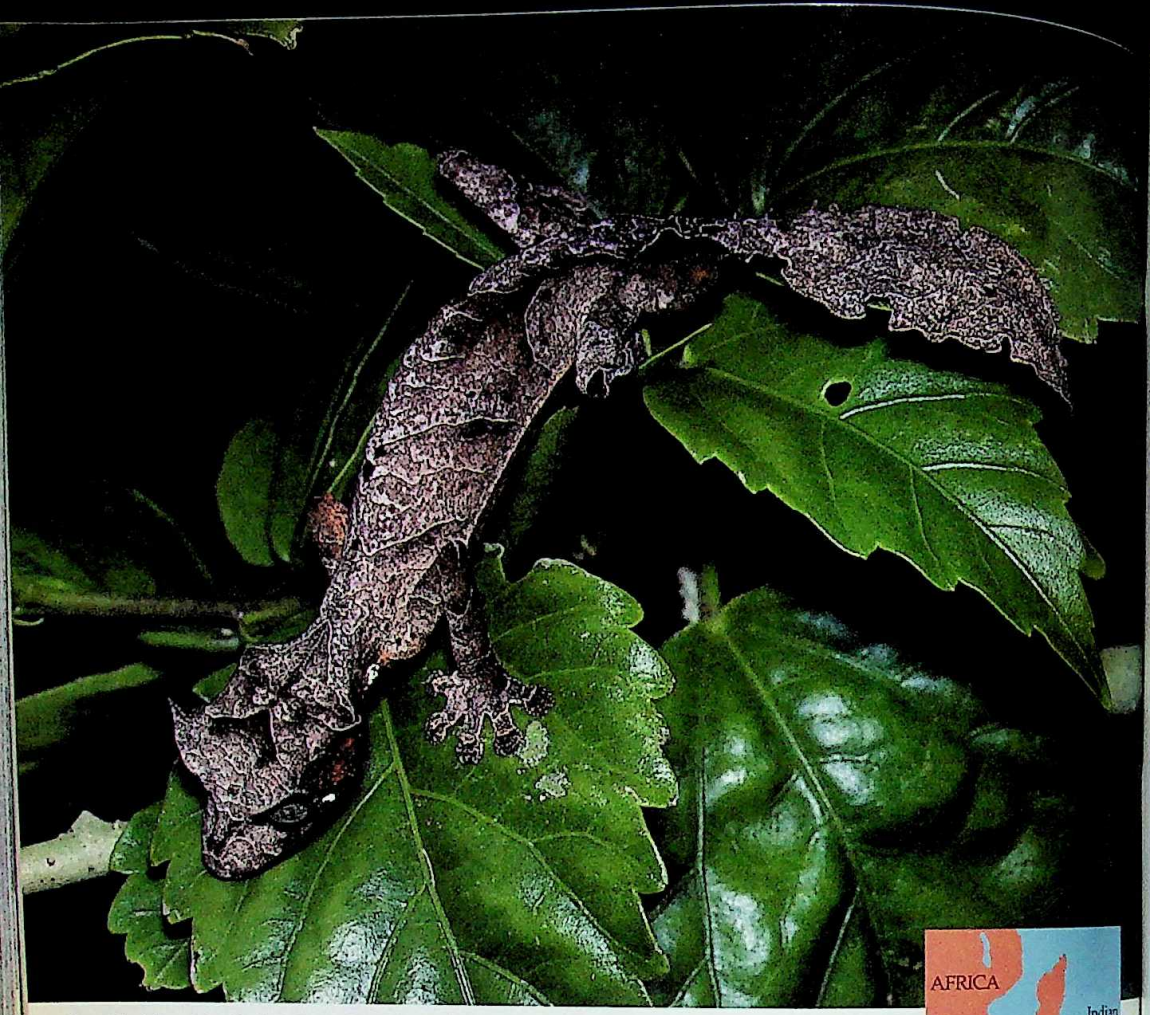

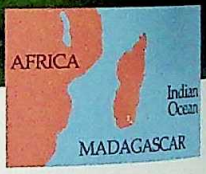

Smooth-skinned Leaf-tailed Gecko *(Uroplatus malama)* **Size:** 120 mm **Weight:** 10 g **Habitat:** Rainforest in southern Madagascar **Surviving number:** Unknown

Photographed by Ronald A. Nussbaum

WILDLIFE AS CANON SEES IT

A master of disguise, the smooth-skinned leaf-tailed gecko hunts for insects in tree branches by night and sleeps undetected by day pressed against a tree trunk. If disturbed, the gecko screams—an attempt to startle the predator long enough to make its escape. Only recently discovered, this leaf-tailed gecko was named for the Malagasy word "malama," meaning smooth. Its smooth skin sets it apart from related gecko species, whose skin is always ornamented with spines or bristles. The future of the smooth-skinned leaf-tailed gecko is uncertain as its remaining rainforest habitat disappears. As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.

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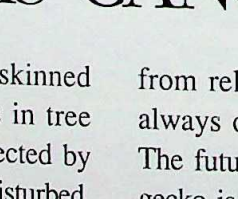

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Focus on Your World

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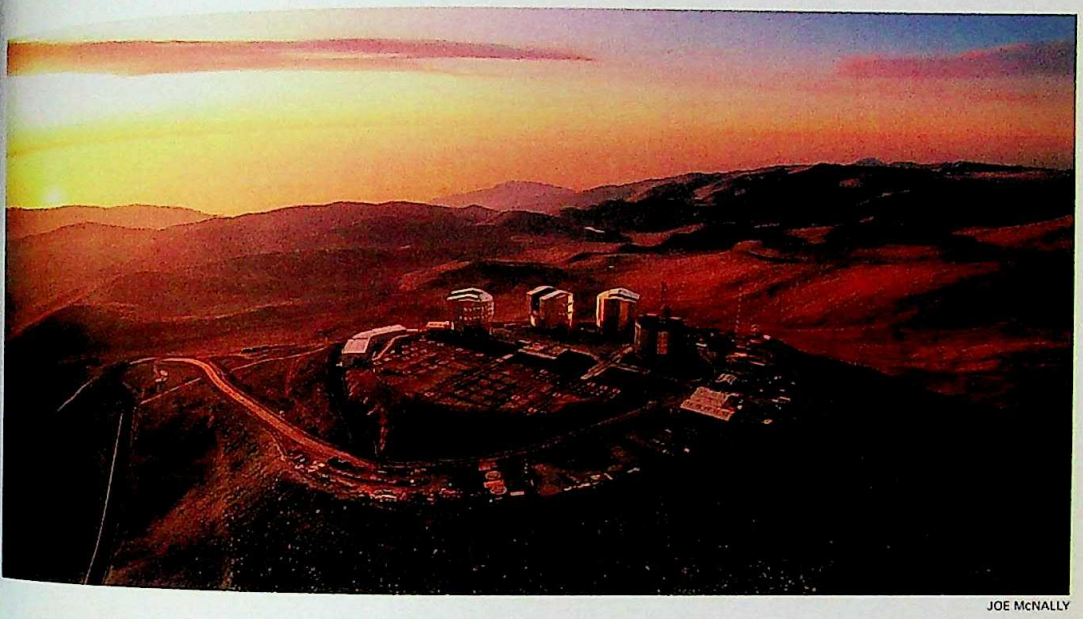

JOE McNALLY

From the Editor

THE LAST TIME a photographer for NATIONAL GEOGRAPHIC flew over the site of the Very Large Telescope (VLT) array on Cerro Paranal, Chile (below), the only sign of human presence was a sheared-off mountaintop. Today four domes rise from the man-made plateau (above), and two of the four huge telescopes are probing the heavens. This transformation illustrates the dramatic advances in astronomy between our 1994 article "New Eyes on the Universe" and this month's report. For example, astronomers have observed galaxies that formed early in the history of the universe and have detected planets orbiting other stars. While for now we seem to be alone in the universe, the search for life beyond Earth continues.

ROGER H. RESSMEYER

With its surprising twists, science is a lot like life. I started out studying physics, and Bill Douthitt, who selected the images for our universe story, wanted to be an astronomer. Now as journalists we're both immersed in the subjects we first loved. And, like scientists, the more we learn, the more we want to know.

Bill Allen

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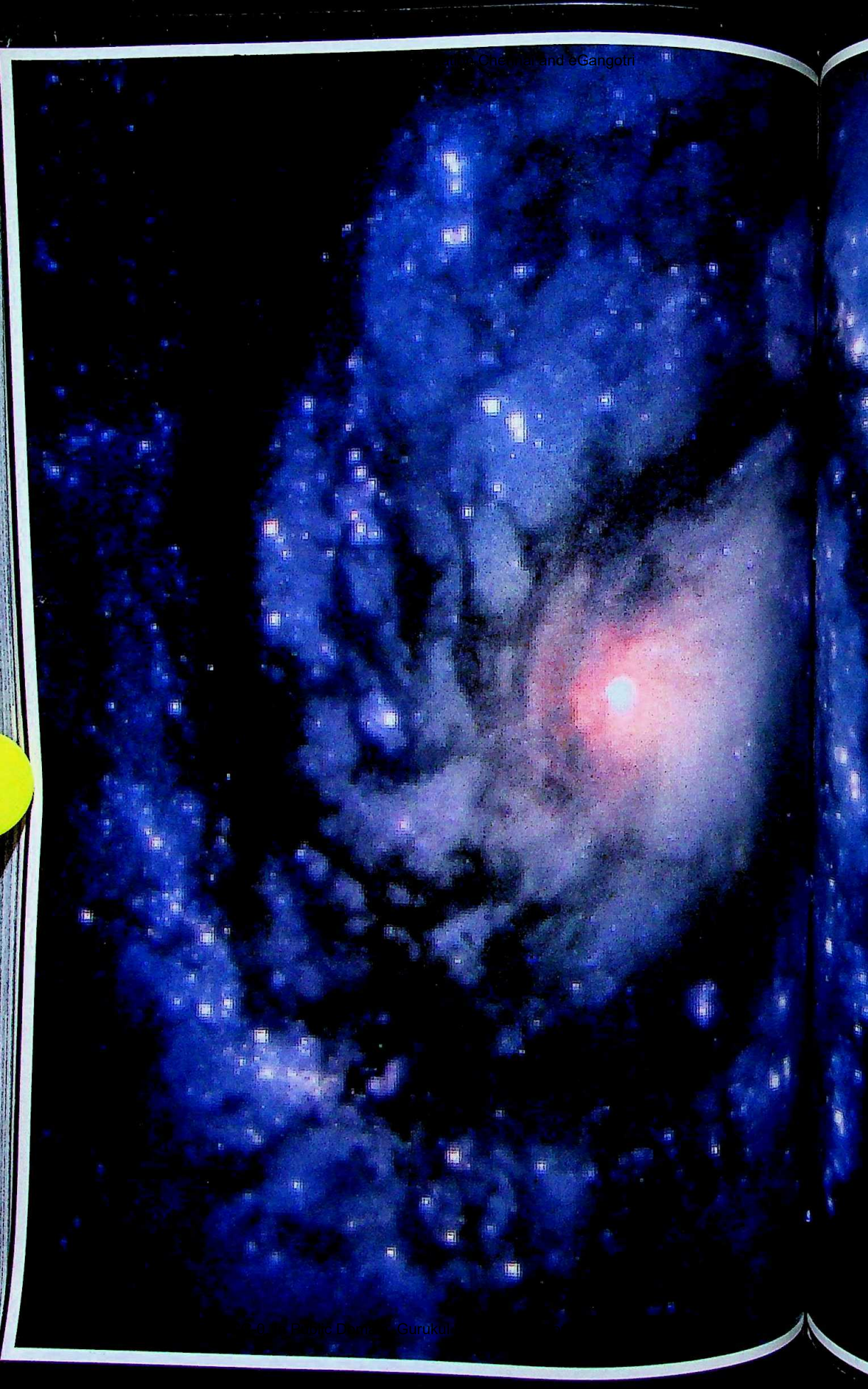

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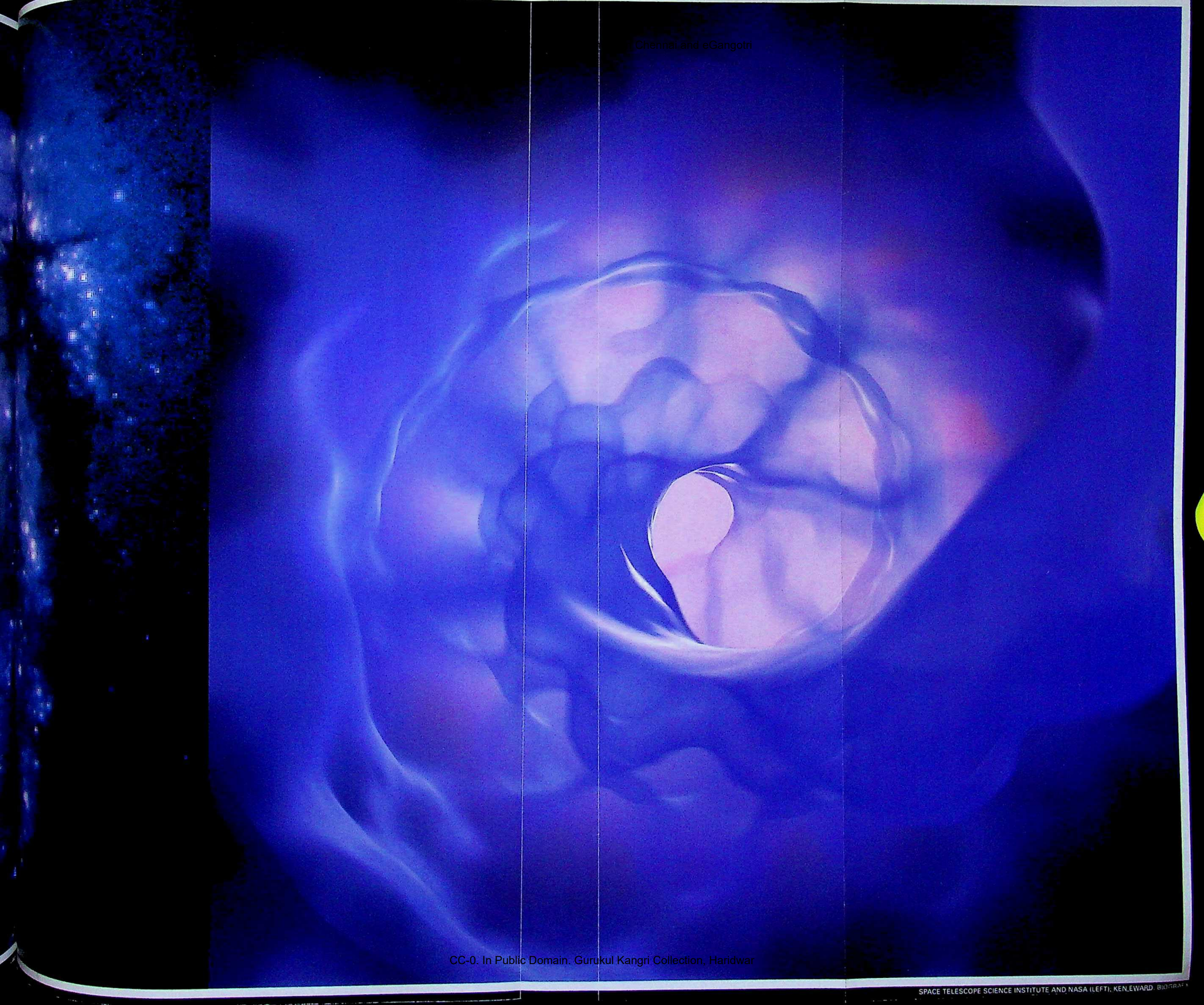

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SPACE TELESCOPE SCIENCE INSTITUTE AND NASA (LEFT); KEN EWARD, BIOGRAP

Asking Infinite Questions SCIENCE

A distant galaxy and a model of DNA spiral into view with suggestive symmetry. The universe and life both seem to be self-organizing. But how do they work? Edwin Hubble observed that galaxies are rushing apart in what must be an expanding universe. James Watson and Francis Crick decoded the molecule essential to life. Such breakthroughs follow when answers to novel questions withstand rigorous scientific testing.

By JOEL L. SWERDLOW
ASSISTANT EDITOR

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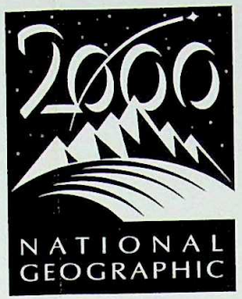
"What good is discovery if you can't



PLANTS CAN COMMUNICATE with each other. ■ Ilya Raskin, a botanist at Rutgers University, shows me how he and his colleagues demonstrated this in an experiment. ■ Dozens of tobacco plants, chosen because of their strong chemical response to a particular virus, were placed in two airtight chambers. Tubes carried air between the chambers. The scientists injected the plants in one chamber with the virus. Within two days those infected emitted a volatile chemical into the air, stimulating the plants in the second chamber to produce chemicals in their leaves that protected them against the virus. ■ This experiment followed the model that guides most scientific research today: Develop a hypothesis, run tests, and produce data that other researchers can confirm or challenge by conducting similar experiments. ■ Until recently botanists did not understand chemicals like those produced by the tobacco plants. But now it's known that plants generate an array of chemicals that protect them against disease and also help them reproduce. Knowledge about such chemicals could lead to the development of hardier plants and to changes in our basic understanding of how they function. ■ "But there's still a huge amount going on in plants that we don't understand," Raskin tells me. ■ Such vast gaps in our knowledge exist in virtually all branches of science. As James Shreeve points out in "Secrets of the Gene," scientists are making extraordinary advances; nonetheless, the purpose, if any, of most information coded in human DNA is not known. Likewise, Kathy Sawyer shows in "New Light on the Universe" that most of the mass that fills the universe has yet to be located. ■ To decipher scientific enigmas it helps to be willing to challenge conventional wisdom. Such wisdom once assumed that the universe was static and unchanging. Now an expanding universe and the big bang theory are cornerstones of cosmology, the part of astronomy that studies the origins of the universe and its time–space relationships. ■ Advances in genetics and astronomy are driven by the number-crunching capabilities of faster computers and by improved imaging techniques that make microscopes and telescopes more powerful. Such tools enable scientists to see things they had never seen before or even considered possible. Genetic researchers can examine objects that are only a millionth of an inch in diameter, while astronomers can see galaxies

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celebrate it with firecrackers?"

—JOHN A. WHEELER, THEORETICAL PHYSICIST

perhaps 11 billion light-years away. ■ It's easy to forget how revolutionary modern science really is. ■ Just a few hundred years ago, in the 16th and 17th centuries, most Europeans thought that the sun revolved around the Earth and that four elements—air, fire, water, and earth—created and defined all life. Scholars mostly parroted what they had learned from classical writers like Aristotle, who believed, among other things, that the Earth was enclosed by celestial spheres where nothing ever changed and everything was always perfect. Then pioneers such as Galileo Galilei and Isaac Newton demonstrated that the natural world can be best understood by experimentation and analysis. ■ Why didn't the scientific revolution (a phrase that didn't come into popular usage until the mid-20th century) take place much earlier? Ancient Greek mathematicians and astronomers had calculated the circumference of the Earth, charted the stars, and figured the distance to the moon. By A.D. 1100 Chinese scholars had developed a seismograph, a magnetic compass, and the concept of infinite empty space. Why didn't the scientific revolution occur in either of those places? Among the best guesses so far: Only in 16th-century Europe did scientists begin to embrace quantification, the use of mathematics to measure the results of experiments. ■ One of the most significant effects of the scientific revolution has been population growth. Until modern science brought sewer systems and immunization in the 19th century, about half of all children died before age five. By the end of the 19th century childhood death rates had fallen, and human population began to surge. With advances in medicine, population continues growing—and further challenging our ability to live in harmony with nature. ■ Will scientific progress continue? Or will science reach some limit like the Pillars of Hercules, the classical and medieval symbol for what lies at the edge of the known? On these gates, according to legend, was written: "*Ne plus ultra*—No further." The Pillars of Hercules for modern science may become moral and spiritual. Scientists—and society—will have to decide how much to change the genetic structures of plants and animals, and whether to tinker with the very genes that make us human. ■ In the meantime the achievements and challenges of modern science propel us further into the unknown. □

The millennium series concludes in December with a look at National Geographic's pioneering use of photographic techniques and a survey that reveals details of the geography of our personal lives.

For more on science and technology millennium coverage, go to nationalgeographic.com/2000/science.

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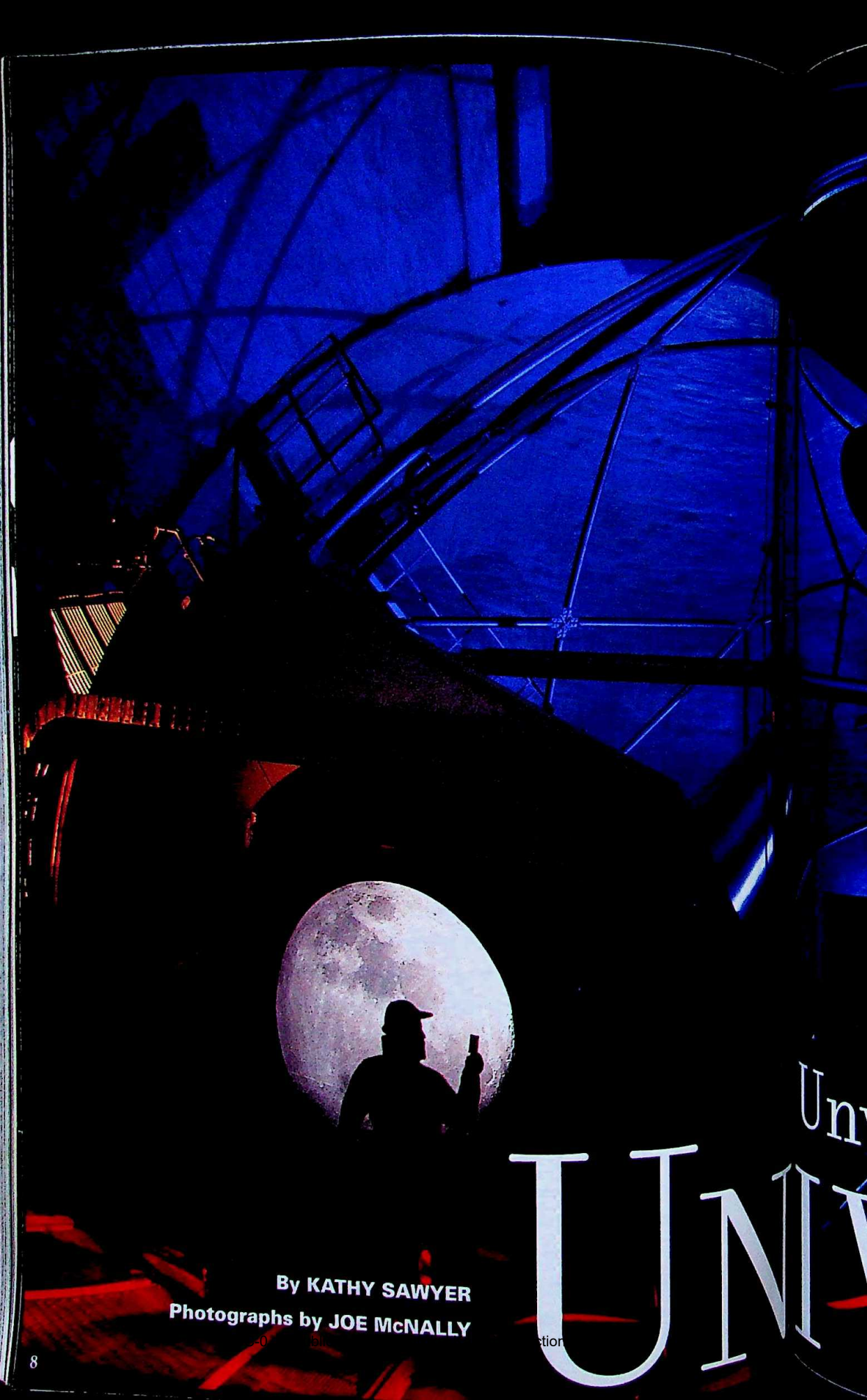

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By KATHY SAWYER

Photographs by JOE McNALLY

Eclipsing the moon, an engineer focuses a projected image on a screen at Hawaii's W. M. Keck Observatory, a major portal for a new age of cosmic exploration.

Unveiling the NIVERSE

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NIGHT BEGINS 13,800 feet up on Mauna Kea, and the dome shutters open atop the ten-meter-wide Keck I and II telescopes. They are among Earth's most advanced: Each has a mirror made up of 36 hexagonal segments that can be individually adjusted by computer.

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By late 2000 they will work in tandem, creating a telescope with as much resolving power as a single mirror 85 meters in diameter. At full power the Kecks will study very distant or faint objects such as planets circling other stars.

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GARY PUNIWAI SITS at the controls of the world's most powerful telescope on the summit of the highest peak in the Pacific, swaddled against the cold. In the eastern sky Orion the Hunter wheels above the horizon, taking aim at the infinite. Puniwai himself hunted wild pigs and sheep on this mountain as a boy, with his brother and two sisters. Now, as operator of the ten-meter-diameter Keck I telescope, he pursues more exotic quarry across the cosmic outback. Night after night Puniwai mans an array of five computer monitors, pointing and clicking to swivel the business end of the 700-ton domed structure toward black holes, exploding stars, gamma-ray bursts, the hiding places of alien worlds, and other phenomena targeted by an international parade of visiting astronomers. But tonight the massive dome won't budge.

HE'S SEEN ONLY on closed-circuit TV, but Gary Puniwai (opposite) has real star power. An observing assistant in the Keck Observatory control rooms on Mauna Kea, he points the telescopes in response to requests from astronomers at the telescopes' home base 48 miles away. Today more and more astronomers are taking advantage of remote technologies to make observations.

In recent days a life-threatening combination of fog, snowstorms, gale-force winds, and black ice on the treacherous, cliff-edged approach roads has periodically forced everybody to abandon the summit and retreat to a base camp farther down. This has meant shutting down all dozen of the telescope facilities that bristle here on the 13,800-foot heights of the dormant volcano Mauna Kea, an otherworldly landscape on the Big Island of Hawaii. Two days earlier an astronomer who flew from England for his one night of observing, booked more than six months in advance, was forced to return home without so much as a microsecond of telescope time.

This evening's disaster is the result of melted snow that seeped through a faulty seal and, at a temperature registering about 20°F, froze in the dome's track. Just before the sun sank with a blood-red splash into the sea of cloud lapping at the volcano's lower slopes, the dome's drive gears locked.

The shaken and exhausted day crew struggled for hours to free the dome, hampered by frigid gusts and lack of oxygen—about half that at sea level—which can cause headaches or vomiting and impair the judgment and memory of the most seasoned worker. They tried pouring antifreeze onto the track. No luck. They tried using a four-wheel-drive van to pull on a cable tied to the dome. The cable snapped. They mobilized a jack with seven tons of force to free the dome but gave up when a support strut began to bend. The icebound dome stared fixedly eastward.

Puniwai, whose authority approximates that of a ship's captain, could have shut down operations. But he prides himself on being conscientious. Besides, this is not some sleepy backwater of science but the booming frontier of trans-cosmic exploration. The night's assigned observers, Matthew A. Malkan of UCLA and Harry I. Teplitz of NASA's Goddard Space Flight Center near Washington, D.C., are not about to surrender easily their few hours of Keck time, valued at about a dollar a second. So they're all running through their options. "We're playing with sky now," Malkan says tensely. "This is very unplanned. . . . It's wild."

To the ancient Egyptians the heavens were almost close enough to touch—a benign canopy of light and dark held up by mountain peaks. But modern science has exploded that ancient, peaceful mirage, replacing it with a cosmos of violence, change, and processes that sometimes defy human understanding. Guided by leaps of imagination and armed with potent new technologies souped up in part as a result of Cold War military advances, scientists have expanded the reach of experimental testing and

KATHY SAWYER is a staff writer at the *Washington Post*. This is her first contribution to the GEOGRAPHIC. JOE MCNALLY, a frequent contributor, chronicled John Glenn's return to space for the June 1999 issue.

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claimed the universe itself as a titanic laboratory. Intruding on mysteries previously confined to the realms of philosophy, metaphysics, and religious faith, these audacious seekers seem on the verge of answering fundamental questions about the origins, scale, and fate of the observable universe, the nature of its contents, the prevalence of other Earth-like worlds—and the potential for kindred consciousness on some of them.

But the universe does not relinquish its secrets easily. For their allotted time with Keck I, Malkan and Teplitz had targeted a list of newborn galaxies eight to ten billion light-years away in the young universe. They intended to study them at infrared wavelengths by using an imager that, attached to the telescope, is capable of detecting the equivalent of a single candle flame on the moon. But the ice seizure forced them to abandon their target list. In a display of resilience under pressure and easy command of an array of high-tech tools—some of which did not exist as recently as two years ago—the two observers turned to the Internet, searched astronomy catalogs, and found all the objects that would pass through the dome's frozen field of view as the Earth rotated.

Once they had selected a few distant objects, Malkan and Teplitz exchanged instructions and information with Puniwai in subdued tones as if the three were working elbow to elbow. In actuality the astronomers were sitting in a comfortable control room with the normal quota of oxygen down in the balmy village of Waimea 48 miles away, communicating with Puniwai via live two-way audiovisual hookup—a growing trend in astronomy. Those who work at the summit, Puniwai says, tend to be "more irritable, and sometimes they have trouble making a decision." He himself suffers from an occasional headache and keeps a binder of notes as a memory backup.

In the end Malkan and Teplitz salvaged at least eight hours of observing time and, by covering unexpected regions of the sky, strengthened their study. In the hours before dawn they also managed to train the telescope on a prodigious burst of gamma rays detected a few days earlier from an unknown source most of the way across the observable cosmos. Astronomers around the world were scrambling at the same time to help record its fast-fading glow. Malkan and Teplitz came away with valuable data about the enigmatic event, which turned out to be the most powerful explosion ever measured.

THE SUN'S LIGHT—traveling at 186,000 miles per second—takes eight minutes to reach us from about 93 million miles away. So we see it as it existed eight minutes ago. Modern telescopes can collect light that has traveled for 25,000 years from the center of our galaxy, indeed, light that has traveled several thousand million years across time and space. Scientists hope eventually to witness the epoch when the first shining stars and galaxies emerged from the primordial gloom.

Cosmic exploration has taken on an air of industrial muscularity as competition builds among larger and fancier machines—and as European

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VENUS AND JUPITER pass just a degree or so from each other through the slit of Mauna Kea's new Gemini North telescope, so named because it will be teamed with a nearly identical telescope 6,600 miles to the southeast, in Chile. Telescope-dome designers have

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long battled the shimmer that occurs when air temperatures inside and outside a dome differ. The Gemini North dome walls separate to reveal a latticework of air vents near its base. As air moves through, temperatures in and around the dome quickly equalize.

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facilities begin to surpass American ones. Modern astronomers are no longer limited to the narrow band of light visible to human eyes or trapped at the bottom of an ocean of atmosphere that either bends or blocks electromagnetic radiation. They can—with continent-spanning strings of linked radio telescopes and ever more sophisticated observatories in space—view virtually the entire rainbow of colors emitted by objects in the cosmos.

Astronomers on both sides of the Atlantic are researching technologies for successors to NASA's Hubble Space Telescope, launched in 1990. Hubble has churned out discoveries and dazzling images, ranging from faint, remote objects to the planets in our own family; captured evidence that black holes really do exist; zeroed in on the age of the universe. The massive Compton Gamma Ray Observatory, the Rossi X-Ray Timing Explorer, the ROSAT X-ray telescope, and a flotilla of other spaceborne instruments have begun to unveil some of the most energetic events in the cosmos. Infrared observing, boosted by a revolution in its technologies, is coming into its own on the ground and in space as a means of studying distant, primeval objects, star-forming regions, and other remote phenomena.

Work is under way to link Keck I to Keck II, its twin at the opposite end of the corridor, creating a telescope with resolving power equal to that of a single, whopping 85-meter-diameter mirror. Along with the Kecks atop Mauna Kea are ten more facilities, making the mountaintop a leading international observing enclave. On other prominences, notably in the Chilean Andes, a similar pattern exists.

One of the most important developments in ground-based astronomy is under way at Apache Point Observatory in southern New Mexico, where astronomers are testing and calibrating the components of the Sloan Digital Sky Survey, a five-year project described as the most ambitious astronomical survey ever undertaken. It is designed to determine the position, brightness, and color of more than a hundred million celestial objects across one-quarter of the sky and measure the distances to more than a million galaxies and quasars—the brilliant beacons believed to exist where black holes swallow up stars and gas at the center of galaxies. Its legacy, if all goes well, will be the first standardized digital atlas of five-color images of the north celestial sphere.

HONEYCOMBED to reduce weight, a record 8.4-meter mirror (opposite) is ground at Arizona's Steward Observatory Mirror Lab for the Large Binocular Telescope on Mount Graham. In Hawaii one of Keck's mirror segments (above) is cleaned with carbon dioxide snow before receiving a new reflective aluminum coating.

As recently as the beginning of the 20th century, conventional wisdom still assumed an unchanging, static universe with no beginning, no end. Then in 1916 Albert Einstein, relying on little more than mathematics and his own profound intuition, came up with the essentials of what would be known as the big bang. But Einstein resisted the implications. It was Alexander Friedmann, a Russian mathematician and meteorologist, who followed through and proposed a model of an expanding universe.

A series of empirical discoveries have since supported that vision. Modern cosmology was launched with the first of these discoveries in 1929, when

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SURVEYING THE COSMOS, scientists from the international team conducting the Sloan Digital Sky Survey gather at Fermilab, near Chicago. The team will create an unprecedented atlas of more than a hundred million celestial objects, covering one-quarter of the

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sky. Still being calibrated, the Sloan telescope has already discovered four of the five most distant quasars ever found as well as a free-floating "methane dwarf," an obscure object that is smaller than a star, larger than a planet.

LEFT TO RIGHT: RICHARD KRON, ELLYNE KINNEY, HEIDI NEWBURG, JEFF HAYNES, JAMES ANNIS, SHU-I WANG, BRIAN YANNY

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Edwin P. Hubble, the American astronomer after whom the space telescope is named, claimed that he had discovered that galaxies are moving apart in all directions.

Hubble had gauged the distances to two dozen galaxies, studying a characteristic of their light known as redshift. Compared with laboratory light, the light from these galaxies—when it passed through a prism and was split into a spectrum of colors—was stretched to slightly longer wavelengths, shifting toward the red. He concluded that the more distant galaxies were racing away from Earth faster than bright, nearby ones. The most familiar explanation of redshift is the Doppler effect, which causes a train whistle to deepen as the locomotive hurtles away from the listener. Across cosmic distances, however, redshift represents the stretching of space itself.

Hubble's findings led to a cosmic narrative that has won remarkable acceptance. Yet within the basic theoretical framework the big bang model continues to undergo mind-boggling refinements.

HOUSED in a rolling shed in New Mexico, the Sloan telescope (above) records light with an advanced array of charge-coupled devices. The light can be further analyzed using an aluminum plate (opposite) drilled with holes that match the positions of selected stars, galaxies, and quasars. The plate allows light from 640 objects to be simultaneously fed to two spectrographs via fiber-optic cables.

BIG BANG THEORY holds that everything in the known universe—all time, space, energy, and matter—was once contained in a point of infinite density known as a singularity. Scientists leave the "why" of that state of affairs to priests and poets. But in the next instant, they theorize, this point began expanding madly in size—pinhead, grapefruit, basketball—to a radius expressed in incomprehensibly large numbers.

After the first millisecond the universe was a featureless fireball about 30 million times hotter than the surface of the sun, 50 billion times denser than lead, and, by the age of one second, it had expanded and thinned to 20 light-years. At that time, presumably, the grainy subatomic ingredients of every leaf, worm, star, rock, manhole cover, automobile, cat, dinosaur, running shoe, and every one of us—all entities past and potential—were combined in white-hot, soupy intimacy with all of space. These initial conditions set immutable limits on the density of all matter and determined the course of cosmic evolution.

The big bang expansion is not an explosion in the classic sense, in which objects are flying out through preexisting space like shrapnel. Space itself is expanding, stretching outward where it had not previously extended, sometimes at velocities faster than the speed of light—a limit that applies to light and other signals but not to space.

The rate at which the universe and all its objects are moving apart—called the Hubble constant—is one of the most important numbers in science. It is expressed in kilometers per second per million light-years (velocity divided by distance). Understanding that number, cosmologists suggest, is key to understanding the natural order of things. The number depends on the amount of "stuff" in the universe, its character, and the degree to which its gravitational forces are retarding the expansion. Those factors in turn affect other events. By tracking the expansion backward, like rewinding a videotape, scientists have sought to define the age, shape, and scale of the universe.

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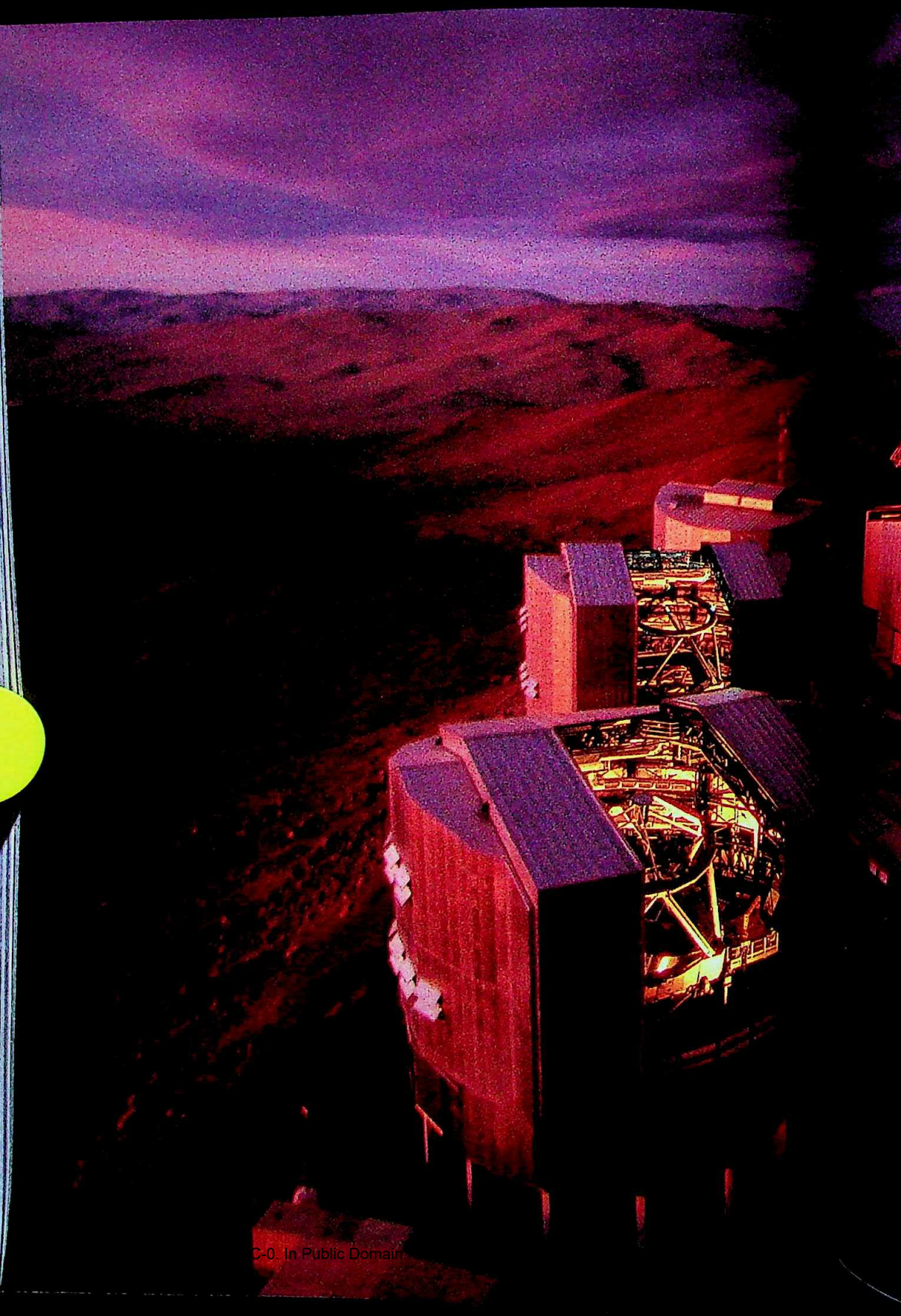
DESERT SENTINELS, the four squared-off domes of the Very Large Telescope (VLT) array have risen on a leveled-off mountaintop on Cerro Paranal in northern Chile. Operated by the European Southern Observatory, two of the four telescopes, all of which will



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eventually work in unison to create images of remarkable sharpness, are already on line. Low humidity and less than an inch of annual rainfall create some of the best telescope "seeing" conditions on Earth for capturing the faint light from distant objects.

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COSMOLOGISTS PORTRAY THE UNIVERSE geometrically in terms of curving lines. Based on Einstein's theories of gravity and the curvature of space–time, they propose three possibilities: a "closed" spherical universe, in which gravity would eventually halt the expansion and draw everything together again in a flaming "big crunch"; an "open," or saddle-shaped, universe, in which there is so little gravity that the outward expansion goes on forever; and a "flat" universe—or a plane—in which the cosmos coasts between the other two possibilities, slowing but never halting. Conventional wisdom holds that the cosmic expansion must be decelerating as gravity exerts its pull, just enough to create a flat universe. But recent observations have threatened to overthrow that view.

The expanding fireball required perhaps 300,000 years to cool and thin out enough to become transparent to light. Then suddenly, as if a fog had lifted, electromagnetic energy was set free to go traveling through the cosmos. According to Chris Impey, a cosmologist at the University of Arizona, that primordial background radiation is today "streaming through our hair" from a time when one part of the universe was separating from another at 50 times the velocity of light. About one percent of the flickering specks seen in the static of a TV screen are triggered by waves of this light. The existence of this cooled and diluted afterglow of creation has provided a strong pillar of evidence for big bang theory to rest upon.

EUROPEAN SOUTHERN OBSERVATORY

Two Bell Telephone Laboratories scientists, Arno Penzias and Robert Wilson, were the first to stumble on this electromagnetic energy in 1964-65, reporting that their experimental radio antenna was picking up microwaves from all directions in the sky. Then, in a meeting of the American Astronomical Society in 1990, a team led by John Mather of NASA's Goddard Space Flight Center announced findings from the Cosmic Background Explorer (COBE) spacecraft that confirmed beyond doubt the nature of the radiation.

For cosmologists the microwave background radiation serves as a stable reference point—the "rest frame" in a cosmos in which everything is in relative motion. Earth orbits the sun at 67,000 miles an hour. The sun travels around the Milky Way once every 225 million years. The Milky Way is falling toward Andromeda, and both are feeling the tug of the great Virgo cluster 50 million light-years away, and so on.

With the existence of this radiation established, Mather's team pushed COBE's sensitivity to its limits and produced an all-sky map that revealed the faint beginnings of clumpiness in the primordial cosmos that had been, to that point, featureless. These small ripples of increased density detected amid the expanding particle soup presumably represented the beginnings of a reverse gravitational snowball effect, in which some regions lagged behind the overall expansion as they pulled in extra mass. This process produced the architecture of the modern universe—at least a hundred billion galaxies congregating in giant clusters and "walls" around great yawning voids. Spacecraft with instruments ten times as sensitive are being designed

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by NASA and the European Space Agency to probe these areas in detail.

No one yet knows how or when the first stars and galaxies began to form in the universe. But astronomers have begun to see back to a time when the universe appears more chaotic and violent, afloat with strange, glowing bits and fragments. They can see quasars, the most luminous objects known in the universe. These objects are believed to be powered by black holes, "places where space itself has been punctured by some colossal collapse," in the words of Martin Rees, Great Britain's Astronomer Royal.

The "ecosystems" of shining galaxies—specifically the thermonuclear processes and explosive death spasms of their stars—are now known to have forged the heavier elements necessary for complexity and life itself. In other words, we are made from the ashes of stellar death. Some scientists have whimsically imagined the meanderings of a single carbon atom, released in the explosive death throes of a star, drifting for eons across intergalactic space, landing in the gas disk that eventually formed Earth, becoming chemically altered, and finally being inserted into a chain of life as part of a nerve cell that guides a human hand to write about it.

WHILE THE BASIC FRAMEWORK of the big bang model has achieved wide acceptance, the view of its shortcomings has grown more sophisticated. As Rees has cautioned, "Our present satisfaction may reflect the paucity of the data rather than the excellence of the theory." As the potential for actually obtaining answers has improved, the questions have evolved through the "whats" and "wheres" to the "hows" and "whys." How did the universe go from simple and smooth to lumpy and complex? Why is it so perfectly balanced gravitationally that it neither flew apart nor crunched back together before the first star or galaxy could form? (This degree of balance has been likened to that of a pencil standing upright on its point. Any tipping at all and it would immediately fall all the way over in one direction or another.) And why does the universe look so much the same over vast distances?

Scientists acknowledge that they have no way of proving any theories about what happened less than .00000000000000000000000000000000000000001 of a second after the bang began. Known as Planck time, or 10 to the minus 43, this is the first fraction of a second in which the laws of known physics apply. Scientists searching for a "theory of everything" have been probing as close as possible to that genesis moment.

Enter "inflation," a theoretical solution that solves a lot of problems for cosmologists. Derived from quantum theory—the study of subatomic particles—it was proposed in 1980. One of its key proponents, Alan Guth of the Massachusetts Institute of Technology, has described it as "the ultimate free lunch." In essence, inflation theory proposes that in the initial bazillionth of a second, the universe underwent a onetime burp, ballooning exponentially (2, 4, 8, 16, etc.) in diameter before settling into the linear expansion (2, 3, 4, etc.) that we see today. In a fraction of an eye blink, according to Andrei Linde, a Stanford University physicist, a microscopic speck would have grown to an expanse more than a hundred billion light-years across. Inflation allows the universe to be incomprehensibly vast.

The implications are in every sense gargantuan. By permitting such a vast space-time geometry, inflation explains how the expanding universe can appear to be flat—and so finely balanced that it can coast toward infinity without either flying apart or collapsing back in on itself.

Until the mid-1990s the data on the rate *(Continued on page 32)*

EARLY IMAGES from the VLT, spectacular as they are, merely hint at the clarity the instrument will achieve after its third and fourth units—and three smaller telescopes—become operational within the next several years. The facility is expected to yield images of intricate structures within galaxies. One of the earliest images from the first unit, named Antu after the sun god of Chile's Mapuche Indians, was this view of the spiral galaxy NGC 2997 in the southern constellation Antlia.

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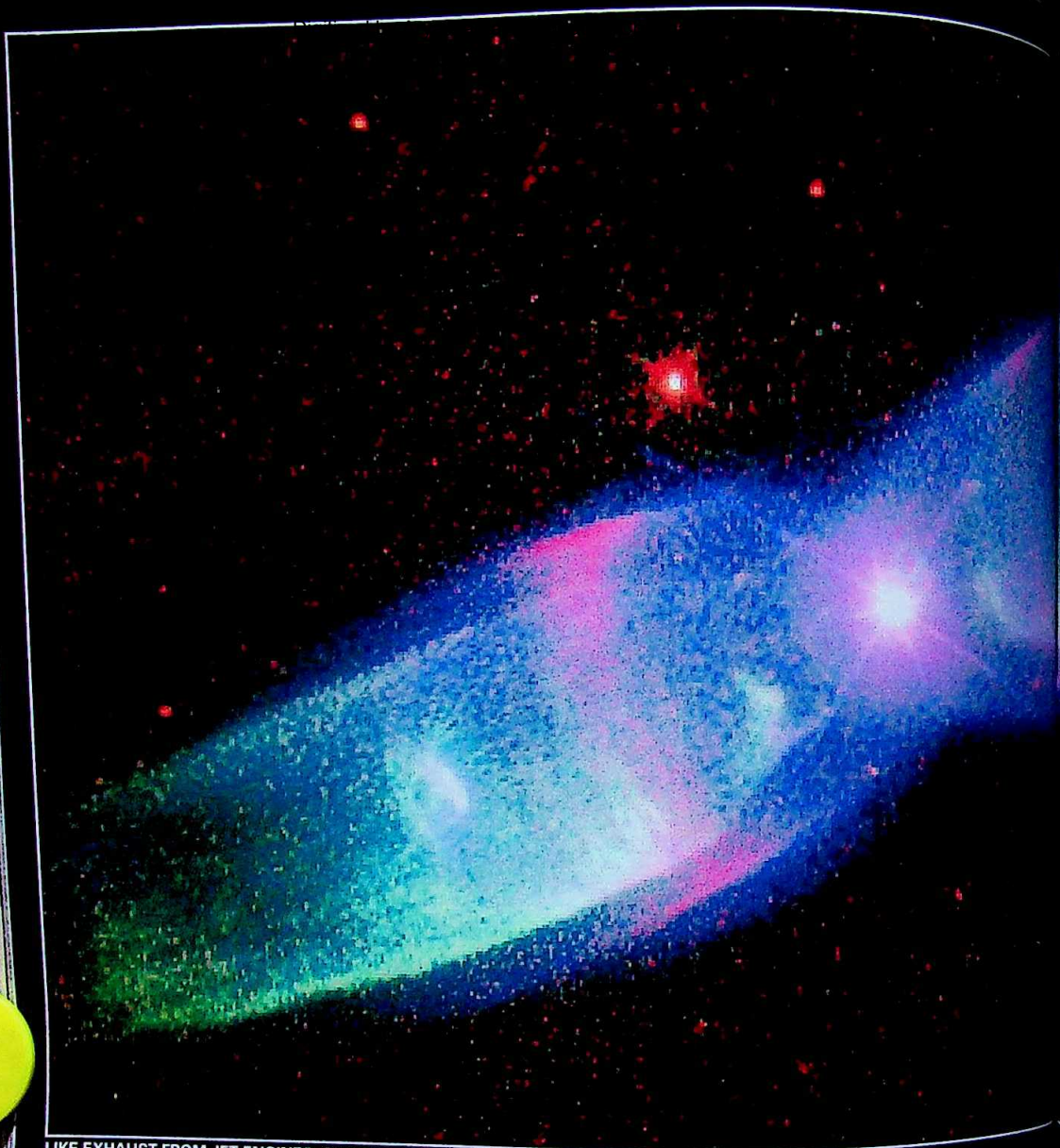
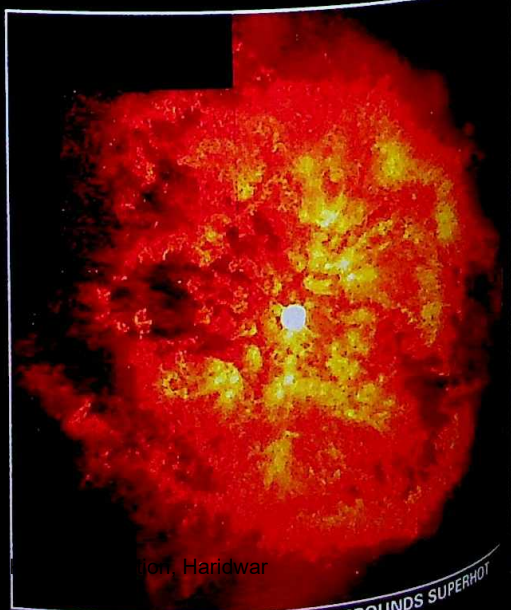


LIKE EXHAUST FROM JET ENGINES, GAS AND DUST OF THE NEBULA M2-9 RUSH FROM A DYING STAR AT MORE THAN 100 MILES A SECOND. BRUCE BALICK AND NASA

STELLAR WIND SHAPES NGC 7635, A BUBBLE NEBULA OF GAS AND DUST. HUBBLE HERITAGE TEAM



GLOWING GAS OF NEBULA M1-67 SURROUNDS SUPERHOT STAR WR124. VLIES OBSERVIES AND NASA

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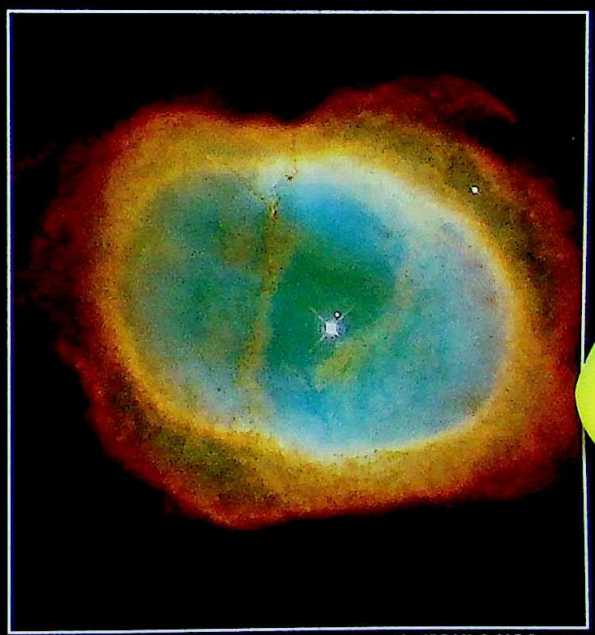
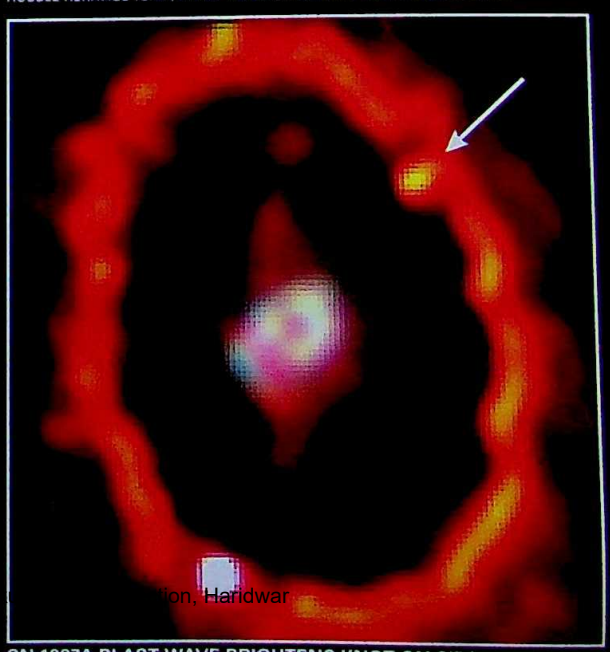
Hubble's Universe

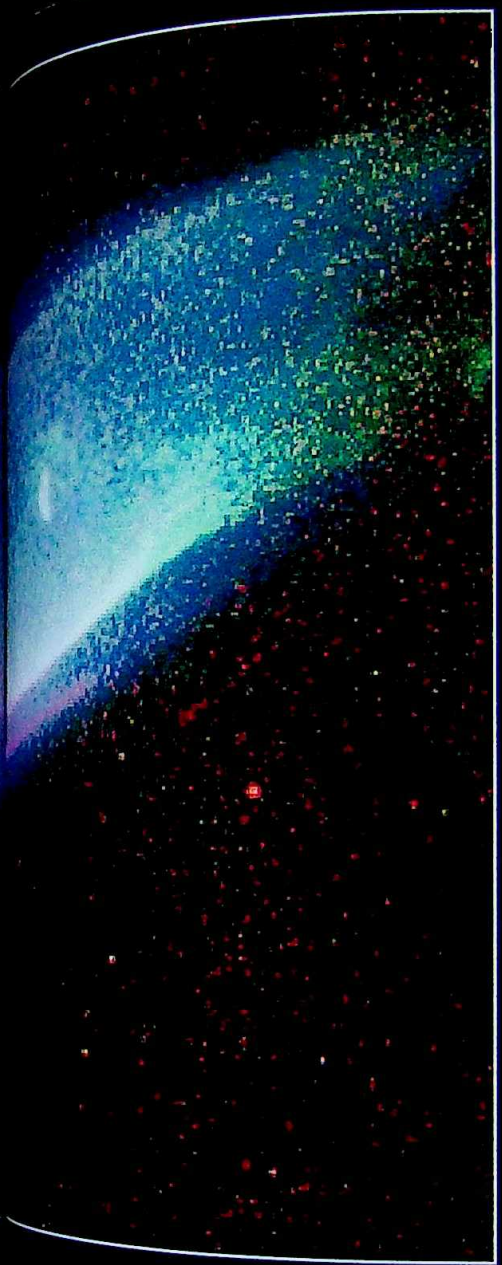
For nearly a decade the Hubble Space Telescope has dazzled with images like these. The telescope recently completed one of the tasks for which it was created and named: measuring the Hubble constant, the rate at which the universe is expanding. Distant galaxies are racing away from us more quickly than nearby ones. By studying the light of some 800 rare pulsating stars, a team recently calculated that for every 3.26 million light-years distant an object is from Earth, it is moving away 160,000 miles an hour faster. Such knowledge helps to establish the age and fate of the universe.

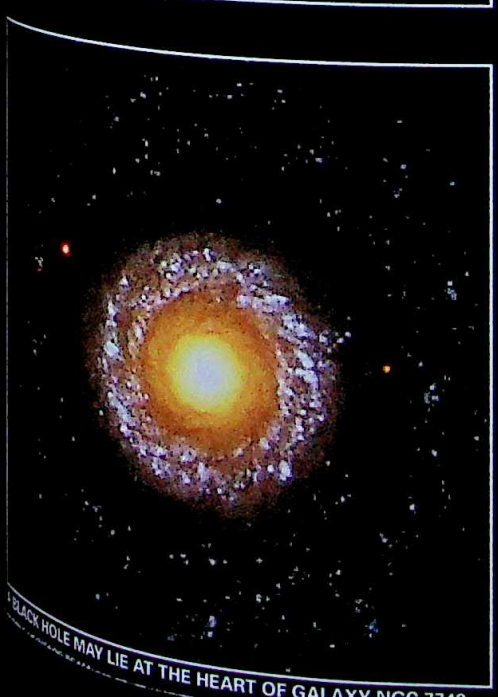


THE SMALLER STAR AT CENTER GENERATES NEBULA NGC 3132.
HUBBLE HERITAGE TEAM, SPACE TELESCOPE SCIENCE INSTITUTE, AND NASA



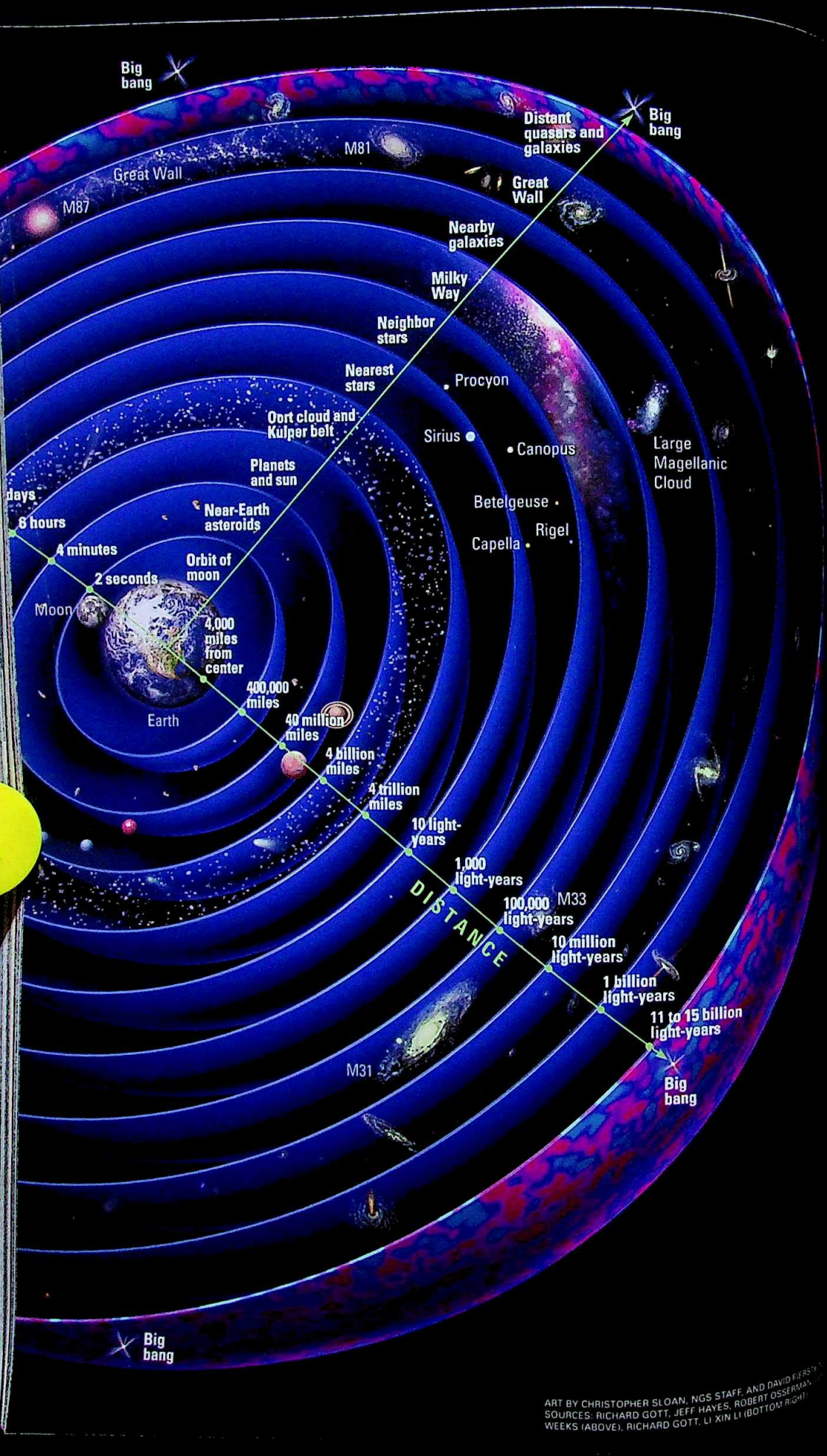
SN 1987A BLAST WAVE BRIGHTENS KNOT ON CIRCUMSTELLAR RING.





BLACK HOLE MAY LIE AT THE HEART OF GALAXY NGC 7742.

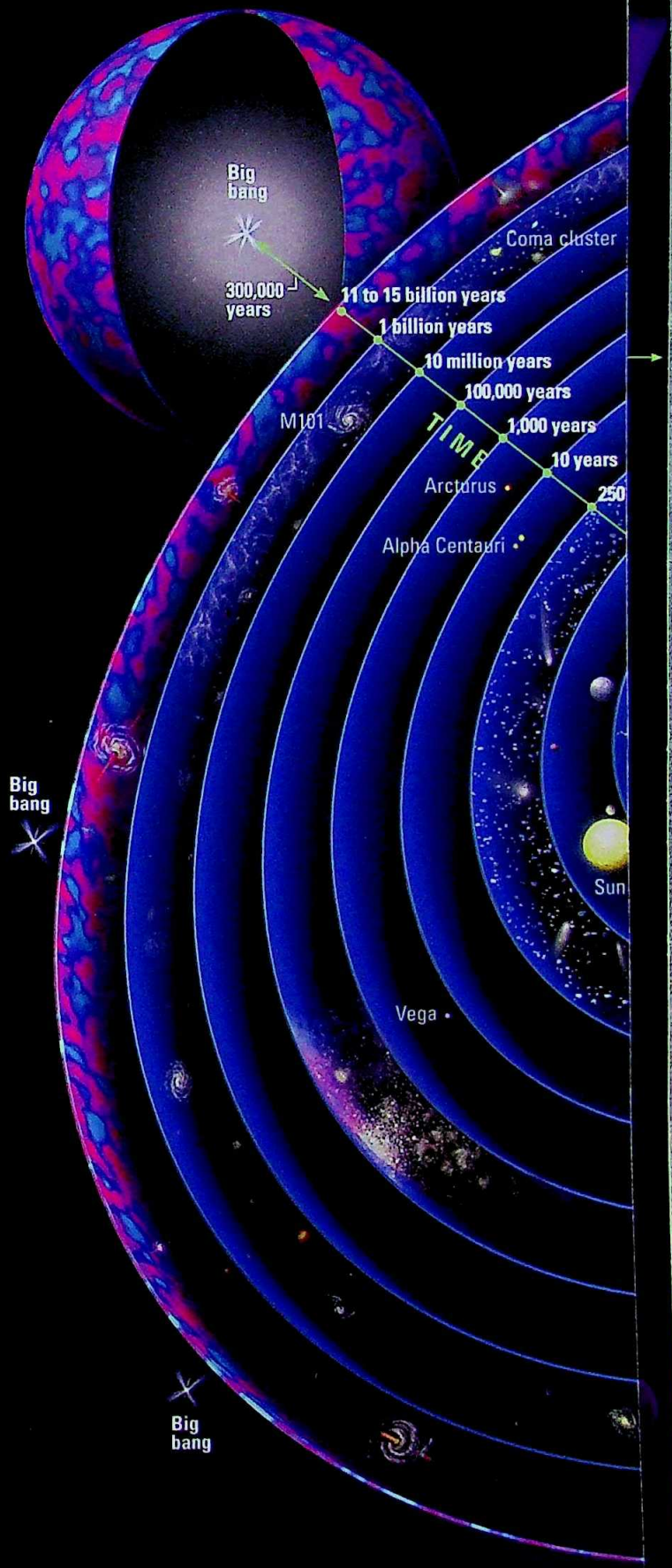
S SUPERHOT



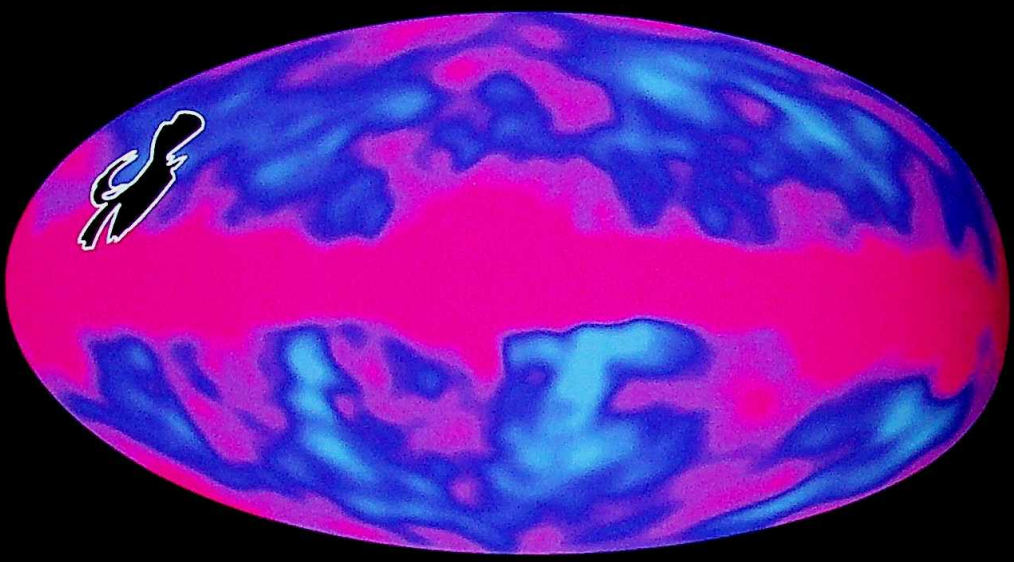
ART BY CHRISTOPHER SLOAN, NGS STAFF, AND DAVID FIERST
SOURCES: RICHARD GOTT, JEFF HAYES, ROBERT OSSERMAN, WEEKS (ABOVE), RICHARD GOTT, LI XIN LI (BOTTOM RIGHT)

The view from Earth

The ancients had it wrong: The Earth is not the center of the universe. But the Earth *is* at the center of the part of the universe that we can see. A being on a planet orbiting, say, a star in the galaxy M87 would see a different part of the universe, one centered on him. In a universe thought to be 11 to 15 billion years old, we can see out a distance of 11 to 15 billion light-years in all directions. From the Earth's viewpoint at midnight GMT, January 1, 2000, the elements of the cosmos will appear as they do here (right). Distances are not shown to scale but increase dramatically as they become more remote. The farther out we look, the farther back in time we see. Light takes 50 million years to arrive from M87, so we see it as it appeared 50 million years ago. The limit of our view is the time when the universe emerged from a state of hot plasma and became transparent, some 300,000 years after the big bang. That period is seen as the glow of the microwave background (shown in red and blue). If we could look beyond that veil, we would see—according to the standard models—the big bang itself, no matter in which direction we looked. The portion of the big bang we could then observe would be a point of infinitesimal size and infinite density.

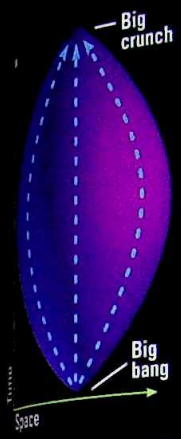


Mapping the Universe

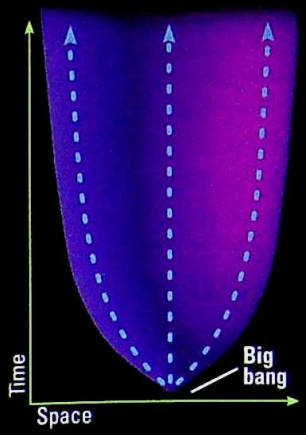


NASA/COBE TEAM, NSSDC (TOP); MAX TEGMARK AND ANGELICA DE OLIVEIRA-COSTA, QMAP TEAM

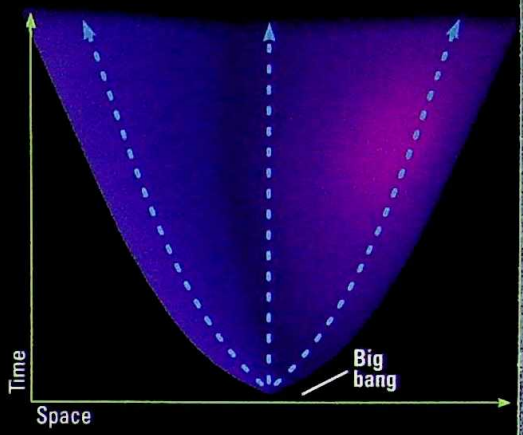
The closest thing we have to a baby picture of the universe is the blob-filled image above, the microwave glow that permeates space. Orbiting above the atmosphere, the Cosmic Background Explorer (COBE) detected patterns of "fossil radiation" that date back to 300,000 years or so after the big bang, a time before galaxies began to form. Radiation slightly warmer than the 2.7-kelvin average is shown in red, cooler in blue. The band across the middle depicts emissions from our own galaxy. It is a remarkable picture but fuzzy: COBE could resolve only areas larger than 15 times the size of the full moon. Scientists are now studying the background with devices that have much sharper resolution. One study, called QMAP, launched a sensor on two high-altitude balloon flights. From their data, scientists developed an image (left) that yields a much more detailed look at the patterns of heat in one area of the infant universe. "From this information we want to learn what the universe is made up of and what it's shaped like," says Max Tegmark of the University of Pennsylvania, a QMAP team member. "We don't have the answers yet, but we now know that the data exist to answer the big questions."



CLOSED UNIVERSE
With density above a critical level, the universe eventually collapses on itself.



FLAT UNIVERSE
At critical density, the universe expands without end, but gravity slows expansion over time.



OPEN UNIVERSE
At less than critical density, the universe expands forever, with galaxies continuing to recede at nearly their current rate.

The fate of the universe

Scientists exploring the ultimate fate of the universe usually start with three standard models.

In the high-density closed universe model (above left) the number of galaxies is finite, and eventually gravity will pull all matter back together in a "big crunch." The flat universe (above center) starts like the closed model, but because it is less dense, it expands forever. It has an infinite number of galaxies. With relatively little density to slow it down, the open universe (above right) grows faster than a flat one. It also expands forever and has an infinite number of galaxies.

Many scientists lean toward the flat model, but refinements are under way as evidence mounts that a mysterious energy in the vacuum of space is accelerating rather than slowing expansion.

But how did the universe start?

Insisting that the cosmic background is too evenly distributed to have resulted from a simple explosion, physicist Alan Guth of the Massachusetts Institute of Technology suggests instead that zones of space smaller than an atom can burst into a period of propelled expansion and matter creation he calls inflation.

Instead of a single expanding universe, Stanford University physicist Andrei Linde advances the notion that chaotic inflation gives rise to multiple universes eternally producing new universes. The origin is pushed to an indefinite past.

What was the initiating event? Richard Gott and Li-Xin Li of Princeton University propose adding a loop to the bottom of the multiple universe model (below), enabling the universe, in Gott's words, "to become its own mother."

SELF-GENERATING UNIVERSES
Multiple universes grow like branches from a tree trunk in a model that allows the universe to create itself.

Digitized by Arya Samaj Foundation Chennai and eGangotri

(Continued from page 25)

of cosmic expansion were so uncertain that the best estimates of the age of the universe stood at between 10 and 20 billion years. Then in 1994 a team led by Wendy Freedman of the Carnegie Observatories in Pasadena, California, startled colleagues with preliminary findings from the Hubble Space Telescope indicating that the universe was astonishingly young—between just 8 and 12 billion years old. This suggested a universe younger than some of its own offspring—its oldest stars, their ages based on the known physics of stellar evolution. Freedman's colleague down the hall, the legendary cosmologist Allan Sandage, led a rival camp whose evidence has continued to support an older universe. Their dueling with data has provided a high-profile demonstration of the process by which scientists converge toward truth. Recently released numbers from the Freedman team, along with those defining the ages of the oldest stars, are pointing toward a universe about 12 billion years old.

GOING DEEP, the Hubble Space Telescope looked at a spot near the south celestial pole for a ten-day time exposure (opposite). The image shows thousands of never-before-seen galaxies along a corridor nearly to the dawn of time. Using ground-based Southern Hemisphere telescopes, astronomers will calculate distances to a number of the brightest galaxies discovered in the image.

The research recently took a surprising turn, however. Answering fundamental cosmic questions depends on correct measurements across great cosmic distances—not easy to achieve. Basically, scientists need to be able to determine whether they are observing a dim object close by or a bright object far away. For this Freedman, Sandage, and other astronomers have sought out extremely bright stars and other objects to serve as "standard candles" whose intrinsic brightness, or "wattage," can be measured.

Such an object must be luminous enough to be detected across billions of light-years. A certain type of supernova—an exploding star—has begun to pay off with spectacular results. Known as Type Ia, it reliably spews out gas and energy in a predictable pattern: The bigger explosions last longer than fainter ones. By monitoring how long explosions last, astronomers can determine their inherent brightness to within 12 percent. Somewhere in a typical galaxy one of these telltale explosions flares about once every 300 years. By monitoring a few thousand galaxies, then, astronomers can expect to see at least one of these supernovae a month.

A couple of international teams have led the effort to comb the heavens for these events—one organized by Saul Perlmutter of Lawrence Berkeley National Laboratory in Berkeley, California, and another led by Brian P. Schmidt of the Australian National University. The work is labor-intensive, requiring researchers to conduct rapid eyeball analysis of hundreds of images. At times, according to Robert Kirshner, a Harvard astronomer, and colleague Nicholas Suntzeff, the Cerro Tololo Inter-American Observatory in Chile, where much of this work is done, "becomes a sweatshop of astronomers and visiting students, who work around the clock for days at a stretch, sustained by enthusiasm and Chilean pizza."

The teams work with large electronic light detectors attached to giant telescopes that can, in a single exposure of an area about the size of Earth's moon, produce a picture of 5,000 galaxies in ten minutes. In before-and-after images of the same patch of sky taken a few weeks apart, computers count the number of photons in each picture, subtracting the total in one image from the total in the other. Significant change in the photon count points researchers to the faint new smudge—often too subtle for the human eye to detect unaided—that represents a faraway supernova. Keck I and II on Mauna Kea, along with the Hubble Space Telescope, perform the final refinements.

In studies of several dozen supernovae four billion to seven billion light-years away, the teams were astonished to find the explosions on average 25 percent dimmer than expected. The researchers have concluded, and a growing number of other scientists agree, that the surprising faintness is caused by

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an unexpected property of the cosmos—that it was expanding more slowly in the past. Or in other words, the expansion is accelerating. Skeptics suggest the dimming could merely be the result of intervening cosmic dust or other distortions or of some intrinsic change in the nature of supernovae over the eons. But team members say that their own rigorous efforts to knock their own findings down, based on those same suspicions, have so far proven futile. Their discovery was named *Science* magazine's "Breakthrough of the Year" for 1998.

An accelerating expansion would assist in bringing the age of the universe into accord with the ages of its oldest stars: If the universe was expanding more slowly in the past, it took longer to reach its current stage than is implied by measurements of the current expansion rate—and therefore could be older than it looks.

In order to accommodate the new evidence of an accelerating universe, some scientists have turned to a fudge factor known as the cosmological constant. This perennial angel has been invoked over the years to bail out problem equations. A concept that Einstein introduced and later dismissed as a mistake, it proposes an exotic repulsive energy that fills "empty" space, separating objects rather than drawing them together as ordinary gravity does. Scientists who study the smallest units of nature have learned that this vacuum is actually seething with activity at the subatomic levels as particles pop in and out of nothingness. Though these are virtual particles, laboratory experiments have shown that they have real and predictable effects. Such particles may be exerting an influence that accumulates across vast distances in a way that is accelerating the expansion of the universe.

NASA AND ROBERT WILLIAMS, SPACE TELESCOPE SCIENCE INSTITUTE

"The cosmological constant is good news for inflation theorists," says Alan Guth, "since most versions of the inflation theory call for a density of matter and energy that flattens the universe." So far astronomers have not found that much matter, but the invisible energy associated with the cosmological constant could be just what is needed. This energy would allow scientists, in essence, to have their cake and eat it too. Now they can have a low-density universe that, thanks to the mysterious energy in the vacuum, is also flat and effectively eternal. The equations work out.

THE NEW FINDINGS, though, are tied up with another frustration. Scientists have long admitted, with some chagrin, that they are unable to locate most of the mass in the universe—the sources of gravity. The evidence for this missing mass comes from two sources: One is the actual observed motions of galaxies, gases, and stars, which would fly apart from each other if there were not some influence much more powerful than their own gravity holding them together. The other comes from inflation theory and its requirement for just the density needed to keep the universe flat.

Scientists have looked high and low for the missing mass. Is it in ghostly dark galaxies, roving collapsed objects, strange particles of energy such as the

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ALL EARS, the Very Large Array (VLA) radio telescope near Socorro, New Mexico, uses 27 movable antennas to gather faint radio signals from across the cosmos. Since coming on line in 1980, the National Science Foundation facility has made detailed images of a host of di galactic c as the sur

uses
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host of distant natural phenomena that emit strong radio waves—the birth of stars, galactic collisions, and the suspected black hole at the center of the Milky Way—as well as the sun and the planets of our own solar system.

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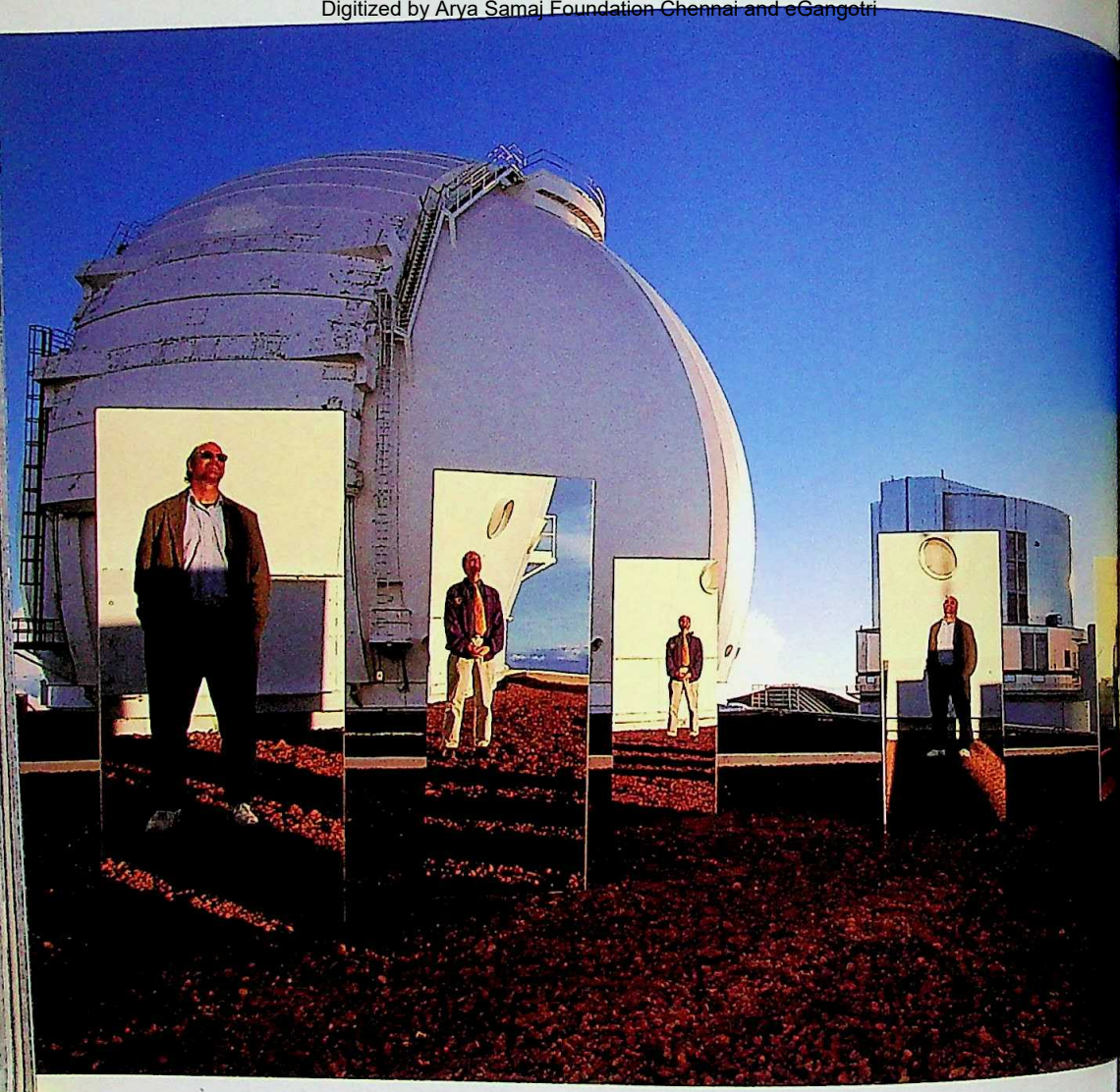

neutrino? An international collaboration of physicists, using the underground Super-Kamiokande detector in Japan, last year shook up their field with evidence that the neutrino, previously thought to have no mass at all, actually weighs about one ten-millionth the mass of an electron. Since the cosmos is aswarm with 1,800 neutrinos per cubic inch—flying unnoticed through our bodies and all other matter and through seemingly empty voids of interstellar space—this is a noteworthy contribution to the total cosmic mass.

Accumulating evidence indicates that the total measured density of all radiation, normal matter, neutrinos, and other bizarre stuff accounts for perhaps 10 to 30 percent of the expected density. In short, there seems to be abundant evidence that, even including the potential quantities of mysterious invisible dark matter, there is not enough to flatten the universe. Again, this requires either revisions in the theory or the aid of the cosmological constant that fills empty space and multiplies its repulsive influence across vast distances. Some scientists, preferring the former alternative, are rummaging around in the early moments of the big bang in search of a different way out of the confusion.

"It's sort of like we're brushing our ignorance under the rug of the very early universe," says Chris Impey.

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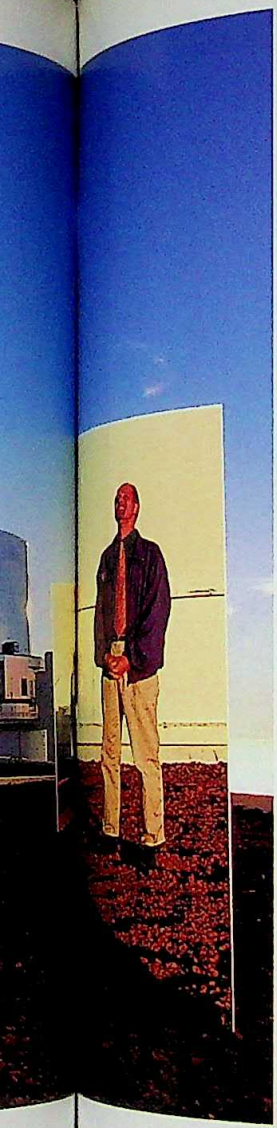

AS OUR IMAGE OF THE UNIVERSE has exploded, humanity has lost the ancient conviction that its role must be all-important. We know now that our planet is an insignificant speck circling an ordinary star, far out on a spiral arm of the Milky Way galaxy, which is an ordinary congress of a few hundred billion stars among at least a hundred billion galaxies.

We are still the only intelligent life we know of anywhere. But now humankind has taken a dramatic leap toward another possible demotion. Until a few years ago the search for worlds beyond the sun was notable primarily for a series of frustrated hopes and claims that collapsed under scrutiny. Then in October 1995 a Swiss team led by Michel Mayor became the first to report the valid detection of a planet around a sunlike star. The scientific community, burned so often, remained skeptical until a team of young, determined Americans led by Geoff Marcy confirmed the Swiss discovery using a precise new technique that has revolutionized the field.

As of April this year the growing number of planet-hunting teams had reported a total of 20 worlds detected in orbit around sunlike stars outside our solar system. This number includes the long-awaited discovery, reported in mid-April, of the first multiplanet system ever detected around a normal star. The tally has grown large enough to reveal unexpected statistical patterns that raise questions about the processes that create and destroy worlds and about the prospects for other life-harboring planets like Earth.

REFLECTING on Earth's origins at the Keck telescopes, astronomers Geoff Marcy, at right, and Paul Butler have led the way in finding planets orbiting distant stars. In 1996 they discovered a planet orbiting the sunlike star Upsilon Andromedae by studying changes in the star's velocity. Recently they found two more planets orbiting Upsilon Andromedae—the first evidence of a solar system beyond our own.

For example, existing techniques can detect only larger planets—on the scale of our own Jupiter. But not one of the extrasolar Jupiters behaves like our Jupiter. They all follow paths much closer to their parent stars and, in most cases, paths that are much more eccentric, or egg-shaped. Scientists say these giants might have swept away any Earth-like siblings early in their development. Yet most sunlike stars appear not to have these marauding giants. More data, along with improved observing techniques, should reveal ever smaller planets, and families of planets that more closely resemble Earth's.

"I feel a personal yearning, at a gut level I can't explain, to understand why this precious little blue globe is the way it is," says Marcy, who, along with colleagues Paul Butler and Debra Fischer, forms the groundbreaking team that has discovered most of the known extrasolar worlds.

Marcy is another veteran of oxygen-deprived nights atop Mauna Kea. But on this particular day he is on home ground, navigating his venerable Honda Civic, festooned with duct tape to hold together a crimped fender, through a schedule that includes teaching a lively morning class on Newtonian celestial mechanics at San Francisco State University, playing tennis, being

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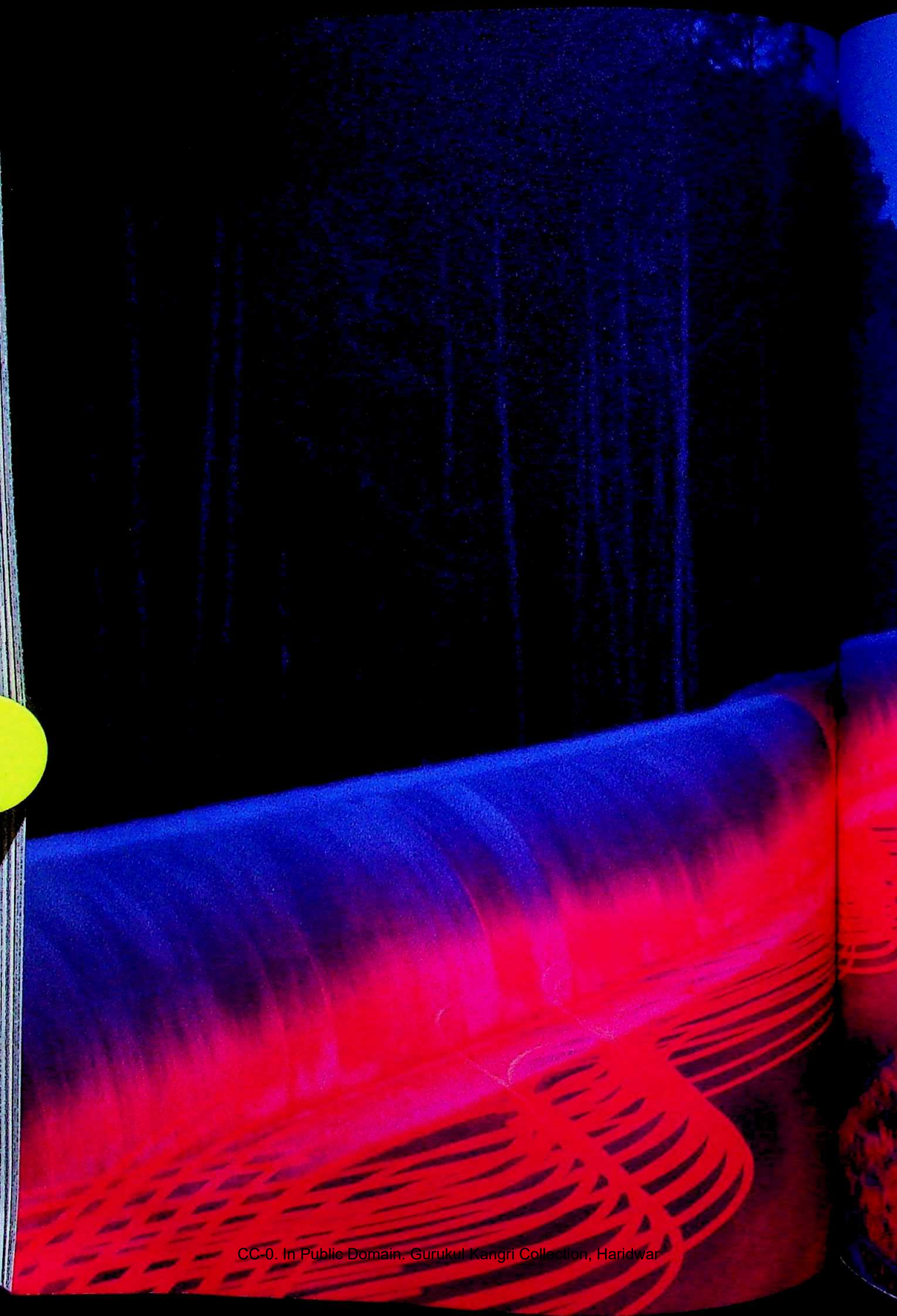
LOOKING FOR GRAVITATIONAL WAVES, the Laser Interferometer Gravitational-Wave Observatory will try to detect ripples in space–time produced by explosions in the distant universe. Einstein predicted such waves, suggested by this time exposure, but they have



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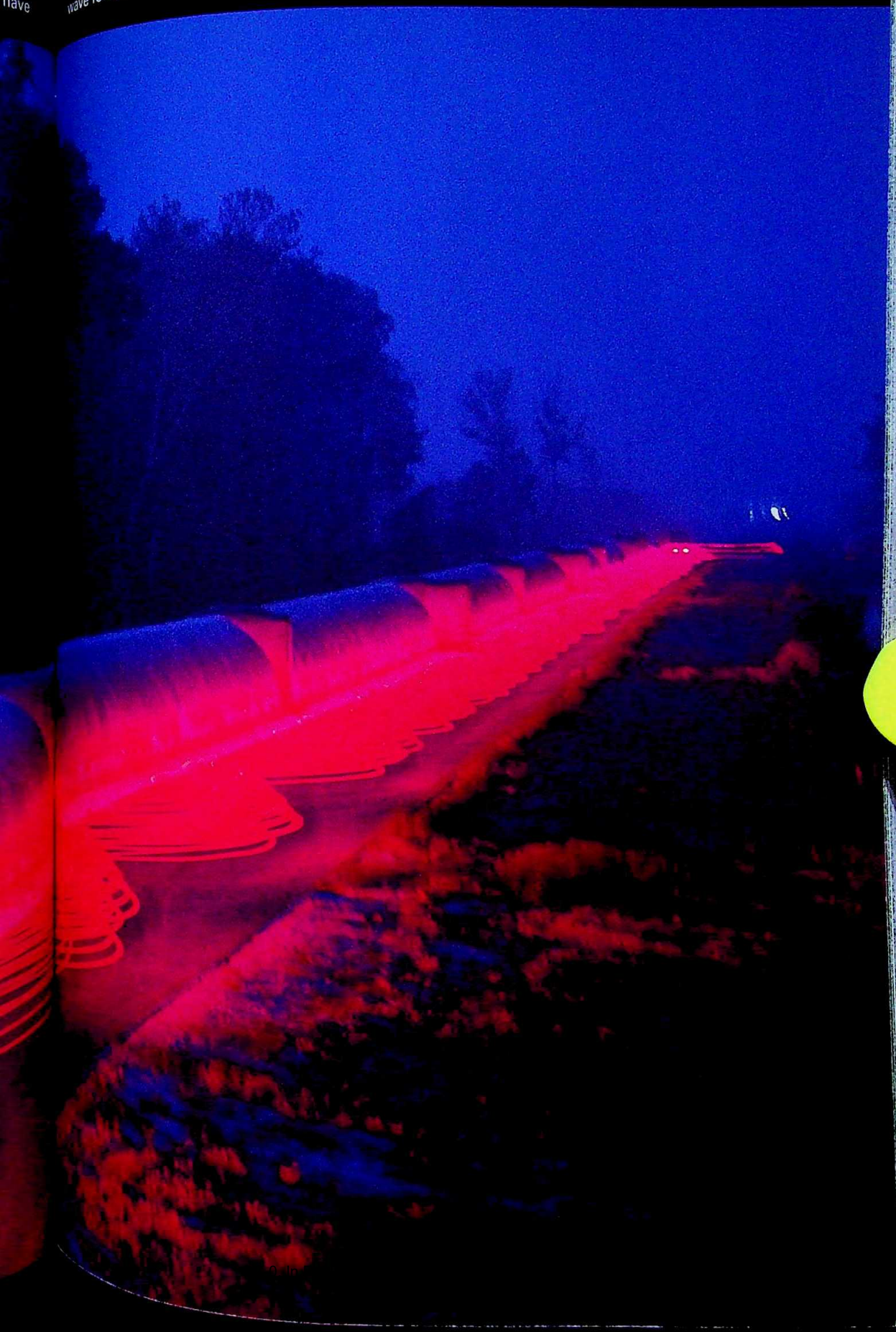
yet to be directly detected. Aiming lasers down long tunnels, LIGO facilities near Living-
ston, Louisiana (below), and Richland, Washington, hope to simultaneously detect the
wave forces moving mirrors as little as one-billionth the diameter of a hydrogen atom.



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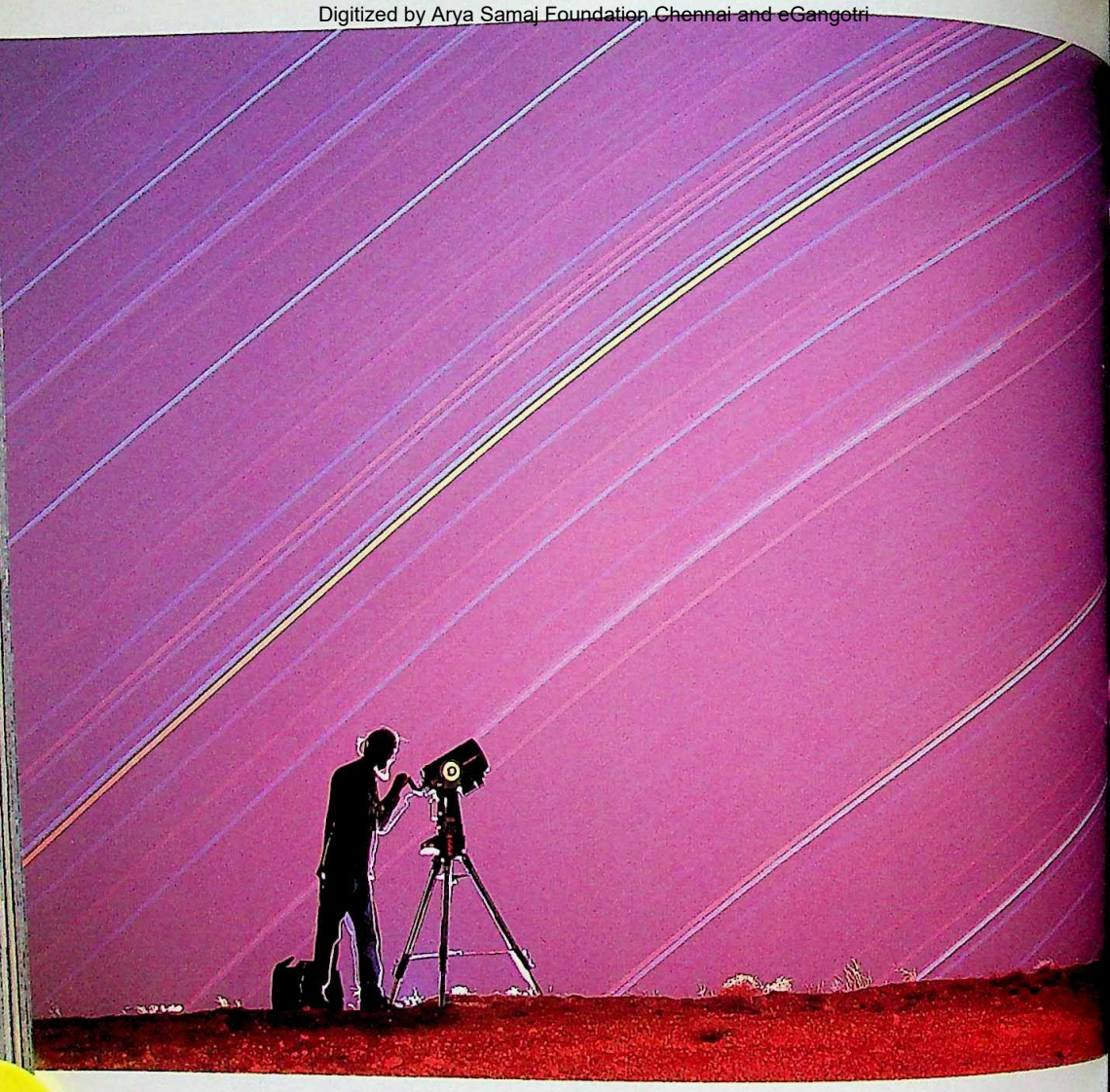

interviewed at the California Academy of Sciences planetarium in Golden Gate Park, and then crossing the Bay Bridge to his other office at the University of California at Berkeley. He works there until about midnight, checking data and calling up computer analyses, watching as the latest discoveries slowly take shape on his computer screen. Along with the thick research catalogs and books on his shelves is a copy of the Little Golden Book of planets.

The data that Marcy, Butler, and Fischer work with do not permit an image of a planet itself, nor do they reveal anything about its surface composition. Looking for a planet around a blazing star light-years distant, even with powerful detectors, is like trying to spot a lightning bug circling in the light of a high-powered spotlight a thousand miles away.

The unique technique that Marcy and Butler developed over an eight-year period uses specially refined hardware and software to effectively chop up the light from stars, looking for the tiny wobble caused in a star when it is tugged by the gravity of one or more circling planets. But as recently as the late 1980s their efforts were disdained by colleagues. Painfully mindful of the embarrassing retractions that had plagued the field, Marcy says that when he and Butler first began to announce results, he felt a mix of "enormous euphoria" combined with "the grotesque fear" that they had blundered—that

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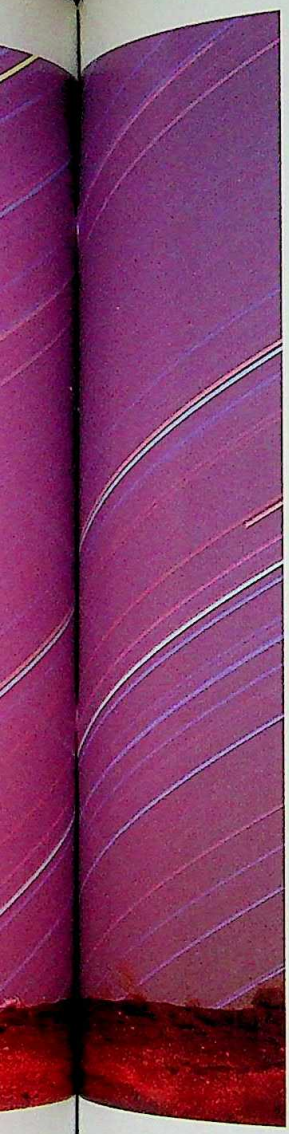

STAR TRAILS in a time exposure silhouette an observer in New Mexico. As radio observatories worldwide combine data to create huge virtual telescopes, scientists plan new telescopes for use in Earth orbit and dream of others beyond Mars. This telescopic golden age is yielding answers to ancient questions—and raising new cosmic mysteries.

their findings were "some outgrowth of a hideous flaw in the software."

Now they are confident they can detect changes in velocity in sunlike stars a few hundred light-years away within a margin equal to about human walking speed. They can describe an unseen planet's minimum mass and orbital period. They are working hard to make their data even more precise, and they plan to combine their results with those of other teams using complementary techniques in a way that should help determine a planet's diameter and whether it is a gas ball or something more dense.

ON MARCY'S BLACKBOARD tonight is a smudged chalk chart listing four telescopes—two at Lick Observatory down the coast, Keck I, and a site in Australia—with observing schedules for his team members. All told, these four telescopes are surveying 800 nearby stars, and they have five to ten new planet candidates incubating at any moment. Butler is 7,500 miles away at the Anglo-Australian Observatory, and Fischer is observing at Lick. "We've got a three-ring circus going here," Marcy says, laughing.

With Bach playing softly in the background, he summons up data that have piqued his interest: more than a decade of information about a star called Upsilon Andromedae. The roller-coaster pattern of dots emits a friendly electron glow in the darkened office. There is a curious scatter, though, a second trend emerging. He calls Fischer at Lick. His suspicions will soon be borne out in headlines around the world: There are three planets circling that star. And astronomers would have been delighted simply to find two around any star other than the sun. Up to now, they had detected no more than one.

Over the next decade NASA's Origins program plans to deploy a series of spacecraft that will culminate in a linked set of giant telescope arrays that will try to zero in on sister planets—"blue marbles" like Earth—by detecting the telltale chemical signature of life in those alien atmospheres. These studies could lead to eventual imaging reconnaissance of such worlds.

For now, humanity can bask in its special status as the only life known to be contemplating such questions. Many scientists predict that this distinction, too, will crumble, perhaps in the new century, as they intensify their search for alien signals and Earth-like worlds. But the search for other worlds is not only a quest for kindred intelligence. As Marcy muses, it is also about "the destiny of the human species. Where are we going to be a hundred million years from now? Where will we go, and how will we get there? And how will it change who we are?" □

Learn how photographer Joe McNally captured the images for this article at *www.nationalgeographic.com/2000/science/universe/.*

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The molecule that programs our biological potential, deoxyribonucleic acid, or DNA, is beginning to yield its secrets. As scientists map our genetic universe (right), we look to the promise of curing diseases and solving mysteries of forensics and

SECRETS OF THE GENE

evolution. But advances bring thorny ethical questions. For example, sperm-sorting technology improves parents' chances of choosing a child's sex—pink-marked sperm (background) will produce girls. Are we ready for the gene age?

By JAMES SHREEVE
Photographs by KAREN KASMAUSKI

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MICROSORT, FAIRFAX, VIRGINIA (BACKGROUND)

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SWINE AND SOMETHING MORE, piglets with a human gene are bred to heal at Virginia Tech's Pharmaceutical Engineering Institute. From their genetically altered great-great-grandfather, each pig has inherited the gene that manufactures the protein known as

factor VIII, a clotting agent needed by type A hemophiliacs. When the pigs mature, females will produce the protein in their milk. "Three hundred to six hundred milking sows could meet world demand," says Bill Velander, the institute's director.

"WE THINK THE SAME. We've even bought each other the same birthday cards," says Geraldine Roberson, right, 15 minutes older than her identical twin and genetic double, Christine Taylor. But they're different in some ways. Only Christine suffers from arthritis,

a condition that burdened their father, whose portrait looks over their Rocky Mount, North Carolina, home. What aspects of behavior and disease are inherited? The Carolina African-American Twin Study of Aging hopes to find clues.

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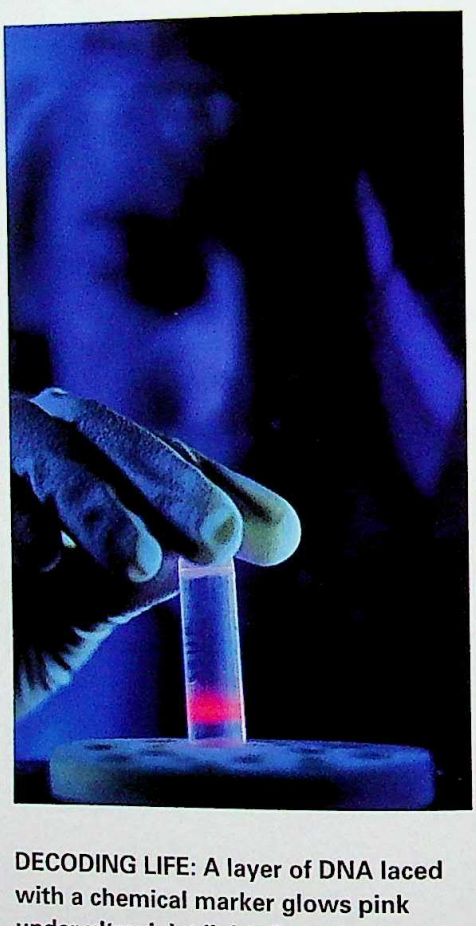
SINCE THIS STORY is about the revelation of secrets, it seems fitting to begin in a room within a room within another room. Before passing through to the innermost chamber, I have been told to cover my clothes and shoes with disposable paper garments and my eyes with plastic goggles. I have put on two pairs of surgical gloves. I have been instructed to leave my notebook outside; nothing brought into the room is allowed to come out, so I must take notes on loose sheets of paper and fax them out to a machine down the hall. Such protocols are necessary because the work in this sterile sanctum—the extraction room at a biotech company called Affymetrix in California's Silicon Valley—sometimes means handling blood containing viable HIV and other deadly infectious agents.

The vial of blood in the room today poses no threat of infection to me, because it is my own. What is about to happen is not normal procedure at Affymetrix or anywhere else, at least not yet. I have come here, after sending my blood in advance, to pay witness to my own genetic code in as complete and intimate a form as the current state of biotechnology will allow. Affymetrix designs and manufactures GeneChip arrays—squares of glass smaller than a postage stamp, planted with millions of strands of DNA, like blades of grass. The chips are essentially probes that researchers and pharmaceutical companies can use to dive into the human genetic landscape and come back with a snapshot of some vital part of its terrain. I have asked Affymetrix to test my DNA with a new GeneChip that will take a crude aerial photograph of my entire genome—the complete genetic script I have inherited from my parents. A copy of that script is spooled along the chromosomes inside virtually every one of my trillions of cells.

A technician pipettes a little of my blood into a test tube, then adds a series of chemicals. It is standard procedure for the extraction of DNA from blood, and over quickly. Half an hour later an Affymetrix scientist named Kyle O'Connor presents me with the work in progress: a creamy speck of raw DNA clinging to the bottom of a blue plastic tube.



DECODING LIFE: A layer of DNA laced with a chemical marker glows pink under ultraviolet light. Organizations around the world are racing to identify every letter, or nucleotide, in our DNA.

"Allow me to introduce you to yourself," says Kyle. For a disorienting moment I am not sure which of us he is speaking to. The notion that something as complex as a human being can be distilled into a test tube is of course absurd. Nevertheless, the pale residue in this vial does contain the chemical guidelines that have informed the development of my body and brain from the moment I was conceived. It holds a detailed record of my ancestral past and to an uncertain extent a forecast of my personal future. It is virtually immortal, a thread tying this one life to all life that has ever lived or is yet to live. But it is also the part of my anatomy most unerringly myself. How much do the secrets in that tube affect the way I look and act, how I respond to the world, and how long I will remain a part of it? To what extent am I my genes?

JAMES SHREEVE is working on a book about the race to uncover the human genetic code, to be published by Alfred Knopf. Of the many articles KAREN KASMAUSKI has photographed for NATIONAL GEOGRAPHIC, she found this story the most emotionally challenging. Everyone she met had "strong feelings about this subject because the perception is that genes define us."

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Such questions are hardly new; they are the essence of the nature versus nurture debate that has perplexed thinkers for centuries. But now we are on the verge of having finite answers. Without much time to consider the implications, scientists have developed the ability to tap into the code of life and bring its power to bear on our daily lives, the way one might conjure up a spirit to intervene in some earthly affair. This eruption of genetic information is transforming the way medicine is practiced, crimes are solved, and the very nature of life is understood. But its power is frightening too, even to those who understand it best. Who has a right to know the secrets written in our genomes? How much do we want to know ourselves?

"There are a tremendous number of ethical issues involved," says Steve Fodor, Affymetrix's CEO and guiding force. "People are stepping very softly in order not to blunder into an area and do things that are irreversible."

Kyle performs more chemical reactions to purify and amplify the DNA in the tube and then transfers it to the GeneChip. It must incubate overnight before we can see the results.

Driving on the freeway back to my hotel, I think about a billboard I passed on another highway when I began this story months ago. Instead of hawking cigarettes or cars, this billboard promoted paternity testing. Looming over the rush hour traffic, it showed a swarm of giant cartoonlike human sperm swimming on a black background, with the message "Who's the father?" in bold letters. In even bolder letters was a phone number made easy to remember: 1-800-DNA-TYPE.

It is time we all got to know our genomes better—and the powers they possess.

FROM THE DOORWAY, the Eagle pub on Bene't Street in Cambridge looks like any other venerable, exceedingly cozy British drinking establishment. It has the distinction, however, of having once been the haunt of a brilliant, brash young Englishman named Francis Crick and a brilliant, even brasher and younger American named James Watson. On the last day of February in 1953 Crick burst through the doorway where I am now standing and announced to all within earshot that he and Watson had found the secret of life. On a rainy October day almost half a century later it seems worth a side trip in my travels to pay homage. I'm just not sure how to do it.

"So this was Watson and Crick's pub?" I mumble to a fellow at the bar. He shrugs. Never heard of the blokes. For a moment I wonder if I'm in the right exceedingly cozy drinking establishment. But the barkeep has overheard my question.

"Abbot," he says.

"Abbot?"

"That's what they drank. Crick and Watson. Abbot Ale."

Never mind how a twentysomething bartender knows what people were drinking 50 years ago—I now know how to pay my respects. I order a pint of Abbot and carry it over to a chair by the fire.

The secret that Watson and Crick (or Crick and Watson, as they are referred to on the Eagle's side of the Atlantic) had uncovered was the shape of a now familiar molecule called deoxyribonucleic acid. A Swiss scientist had isolated the chemical from the white blood cells of pus way back in 1869, but neither he nor anyone for over half a century had any idea of its importance to life. It wasn't until a few years before Watson and Crick began work that an American bacteriologist named Oswald Avery demonstrated that DNA was the stuff of genes—discrete, inheritable packets of information aligned along the chromosomes inside the cell's nucleus.

Watson and Crick puzzled out that DNA is shaped like a twisted staircase—the famous double helix. The two strands of the helix consist of immensely long strings of subunits called nucleotides. These, in turn, contain sub-subunits called bases that are referred to by the letters A, T, G, and C. (They stand for adenine, thymine, guanine, and cytosine.) Think of those four bases as letters in a four-letter alphabet. Just as we arrange the letters of our alphabet into meaningful words, the A's, T's, G's, and C's that make up our genes are arranged into three-letter "words" comprehensible to the machinery of the cell. Each gene is a sentence composed of a precise order of these words, telling the cell to manufacture a particular protein, be it an enzyme that helps you digest your lunch, an antibody marshaled to fight off an otherwise lethal infection, or one of the *(Continued on page 54)*

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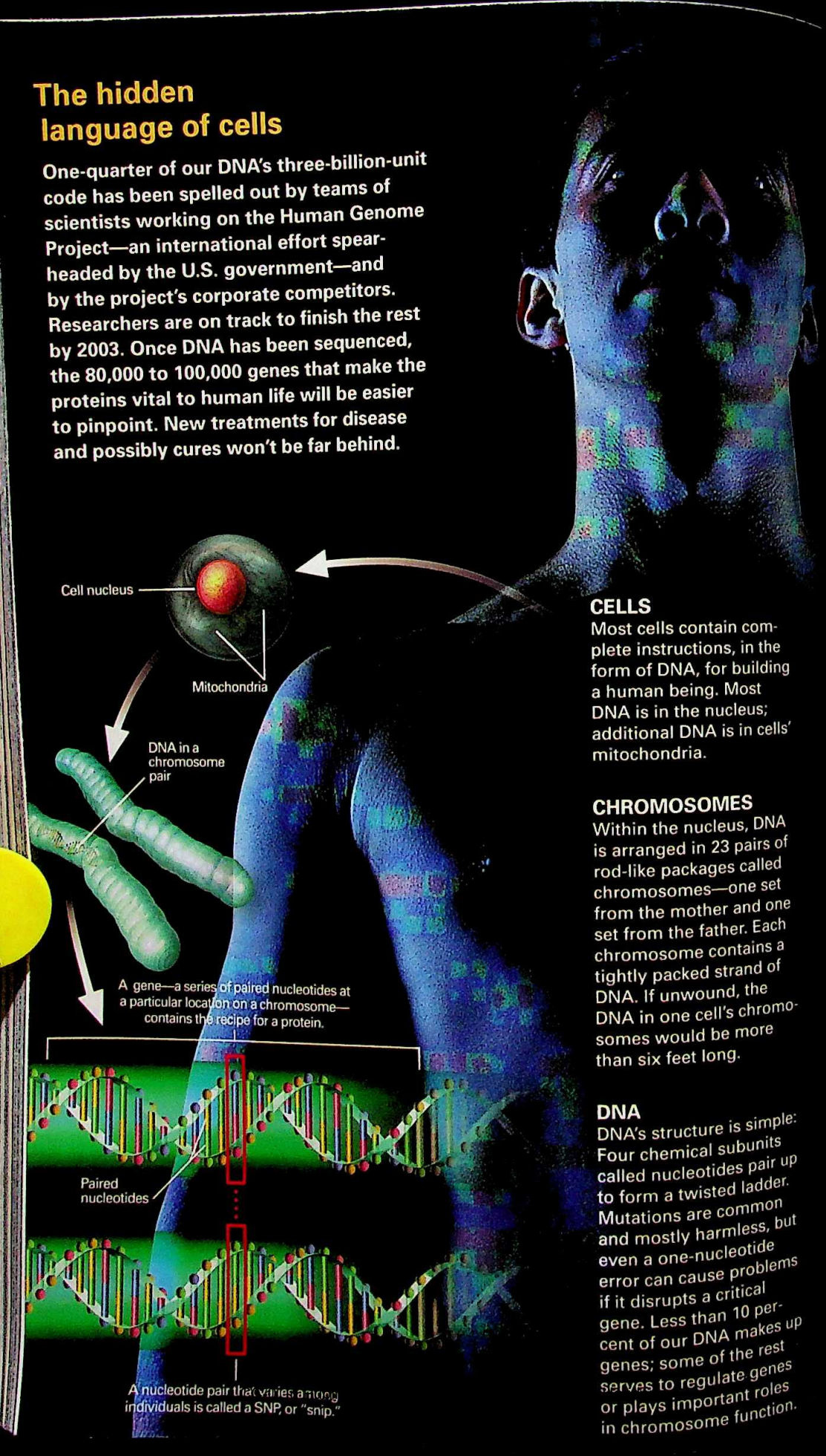
The hidden language of cells

One-quarter of our DNA's three-billion-unit code has been spelled out by teams of scientists working on the Human Genome Project—an international effort spearheaded by the U.S. government—and by the project's corporate competitors. Researchers are on track to finish the rest by 2003. Once DNA has been sequenced, the 80,000 to 100,000 genes that make the proteins vital to human life will be easier to pinpoint. New treatments for disease and possibly cures won't be far behind.



CELLS

Most cells contain complete instructions, in the form of DNA, for building a human being. Most DNA is in the nucleus; additional DNA is in cells' mitochondria.

CHROMOSOMES

Within the nucleus, DNA is arranged in 23 pairs of rod-like packages called chromosomes—one set from the mother and one set from the father. Each chromosome contains a tightly packed strand of DNA. If unwound, the DNA in one cell's chromosomes would be more than six feet long.

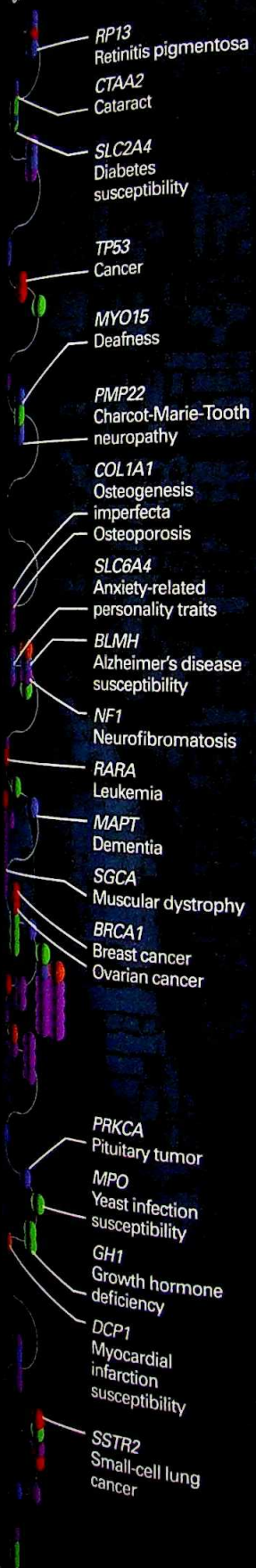
DNA

DNA's structure is simple: Four chemical subunits called nucleotides pair up to form a twisted ladder. Mutations are common and mostly harmless, but even a one-nucleotide error can cause problems if it disrupts a critical gene. Less than 10 percent of our DNA makes up genes; some of the rest serves to regulate genes or plays important roles in chromosome function.

The stories in our genes

Cancers · Cardiovascular disorders · Other · Metabolic/endocrine disorders · Neurologic/psychiatric disorders

Someday DNA tests may provide instant snapshots of future ailments and life expectancy, but not yet. Genes for more than 1,200 disorders have been identified (selected examples below and left), but most people probably can learn more from their parents' health history than they can from a DNA printout (background). Most of us carry a few defective genes with no signs of disease, and many genes only contribute to susceptibility. Lifestyle choices such as diet and smoking and environmental factors can raise or lower disease risk.



CHROMOSOME 1
- Malignant melanoma
- Prostate cancer
- Deafness

CHROMOSOME 2
- Congenital hypothyroidism
- Colorectal cancer

CHROMOSOME 3
- Susceptibility to HIV infection
- Small-cell lung cancer
- Dementia

CHROMOSOME 4
- Huntington's disease
- Polycystic kidney disease

CHROMOSOME 5
- Spinal muscular atrophy
- Endometrial carcinoma

CHROMOSOME 6
- Hemochromatosis
- Dyslexia
- Schizophrenia
- Myoclonus epilepsy
- Estrogen resistance

CHROMOSOME 7
- Growth hormone deficient dwarfism
- Pregnancy-induced hypertension
- Cystic fibrosis
- Severe obesity

CHROMOSOME 8
- Hemolytic anemia
- Burkitt's lymphoma

CHROMOSOME 9
- Dilated cardiomyopathy
- Fructose intolerance

CHROMOSOME 10
- Congenital cataracts
- Late onset cockayne syndrome

CHROMOSOME 11
- Sickle-cell anemia
- Albinism

CHROMOSOME 12
- Inflammatory bowel disease
- Rickets

CHROMOSOME 13
- Breast cancer, early onset
- Retinoblastoma
- Pancreatic cancer

CHROMOSOME 14
- Leukemia / T-cell lymphoma
- Goiter

CHROMOSOME 15
- Marfan's syndrome
- Juvenile epilepsy

CHROMOSOME 16
- Polycystic kidney disease
- Familial gastric cancer
- Tuberous sclerosis-2

CHROMOSOME 17 (shown at left)

CHROMOSOME 18
- Diabetes mellitus
- Familial carpal tunnel syndrome

CHROMOSOME 19
- Myotonic dystrophy
- Malignant hyperthermia

CHROMOSOME 20
- Isolated growth hormone deficiency
- Fatal familial insomnia
- Creutzfeldt-Jakob's disease

CHROMOSOME 21
- Autoimmune polyglandular disease
- Amyotrophic lateral sclerosis

CHROMOSOME 22
- Ewing's sarcoma
- Giant-cell fibroblastoma

X CHROMOSOME
- Colorblindness
- Mental retardation
- Gout
- Hemophilia
- Male pseudohermaphroditism

Y CHROMOSOME
- Gonadal dysgenesis

MITOCHONDRIAL DNA
- Leber's hereditary optic neuropathy
- Diabetes and deafness
- Myopathy and cardiomyopathy
- Dystonia

SOURCE: VICTOR A. MCKUSICK, JOANNA AMBERGER, AND ADA HAMOSH, ONLINE MENDELIAN INHERITANCE IN MAN (WWW.NCBI.NLM.NIH.GOV/OMIM/) AND GREG SCHULER, NATIONAL CENTER FOR BIOTECHNOLOGY INFORMATION; ART BY CHRISTOPHER SLOAN, NGS STAFF, AND DOUG STERN; PHOTOGRAPH BY O. LOUIS MAZZATENTA

Living With Alzheimer's Disease

The first symptoms of Alzheimer's disease hit Ina Savage, 58, about a decade ago. The woman who organized her Baltimore family's life began to forget what to buy at the grocery store and what to pack for vacations. Then in 1996 the diagnosis came: early-onset Alzheimer's, a form that strikes before age 65 and accounts for about 15 percent of cases. Ina is still feisty and talkative, but she's not the person her husband

and children remember. Her daughters guide her to and through the supermarket. Dressing is a challenge. Recipes slip from her mind.

Eight genes have been linked to Alzheimer's, but there's no cure yet, and conclusive genetic tests won't be available for several years. Would Ina's daughters take such a test? "It would be irresponsible not to; I want to start a family," says Serena (with newspaper). Pauline (red hair) disagrees: "If I get Alzheimer's, I get it." Lina is cautious. "What if an insurer learned the test was positive and decided not to pay for treatment?"

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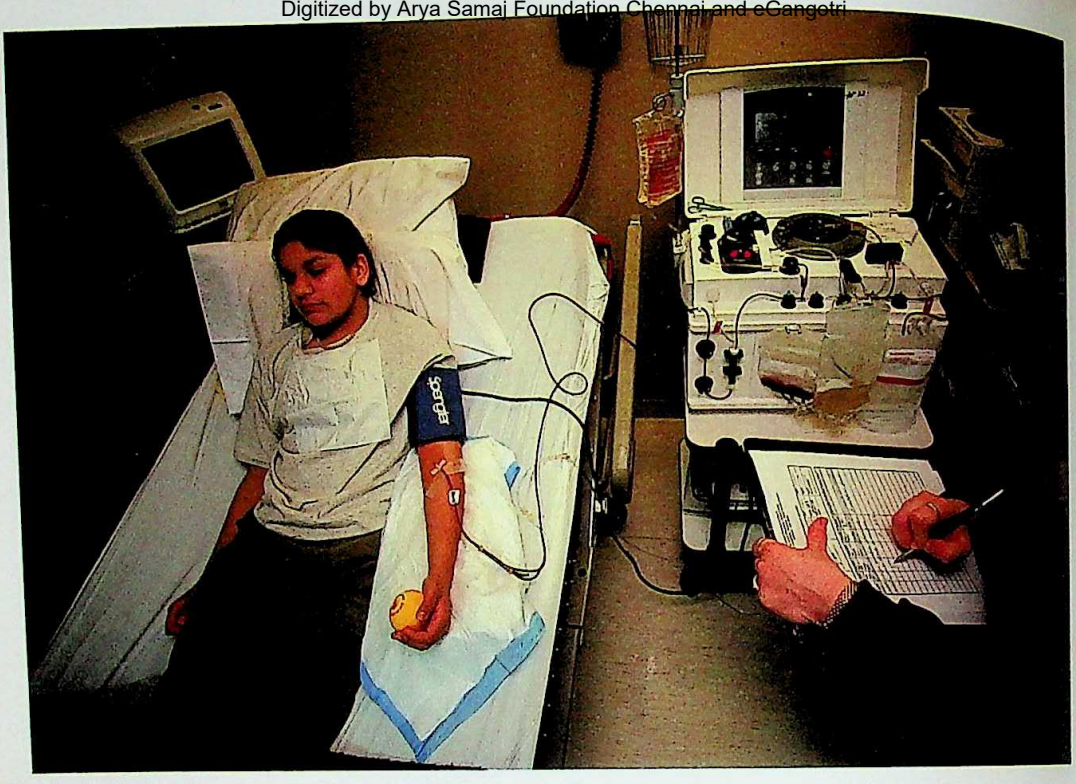

PIONEER Ashanthi De Silva was, at age four, the first human to receive gene therapy, a procedure that inserts new DNA to do the work of defective genes. Now 13, she still gets follow-up care for her rare immune disorder (above), but she is able to attend school (opposite), where classmates treat her like anybody else. Scientists and reporters are more bothersome, she admits. "But if it helps people learn, it's good."

receptor proteins in your brain that enables you to read and understand this paragraph.

That simple formula—one gene makes one protein—is part of the central dogma of molecular biology. Like any dogma, it skips over a great deal of detail. In order to make a protein, a gene actually needs help from all kinds of other proteins, such as hormones and enzymes. It needs to know when to turn itself on and when to turn off.

The genes of higher organisms are especially complex, their chemical messages riddled with meaningless strings of letters that have to be spliced out before the genes can do their work. Byzantine patterns of repeated words and lengthy sprawls of seemingly nonsensical sequences mask essential instructions not yet understood. None of this was known, of course, back when Watson and Crick were celebrating in the Eagle pub.

"The great and wonderful thing about DNA back then was that it seemed so simple," says Jim Watson today in his office at Cold Spring Harbor Laboratory on Long Island. "Initially everyone *liked* DNA. It's not that we dislike it now, but it's frightening trying to figure out what you do with all that complexity. My brain can't handle it."

IF YOU ARE LOST, it helps to have a map. I drive south out of Cambridge to keep an appointment at the Sanger Centre, an elegant thrust of concrete and brushed metal rising from the grounds of an old estate. The Sanger Centre is one of the most productive contributors to the international Human Genome Project, a multibillion-dollar effort to map all the estimated 100,000 genes on our 23 pairs of chromosomes and read their entire sequence, letter by letter. It is a colossal task, for there are billions of letters.

"All the information required to make a human being is written into our DNA," says John Sulston, the Sanger Centre's affable, bushy-bearded director. "We can even put an upper limit on the size of it—about a gigabyte

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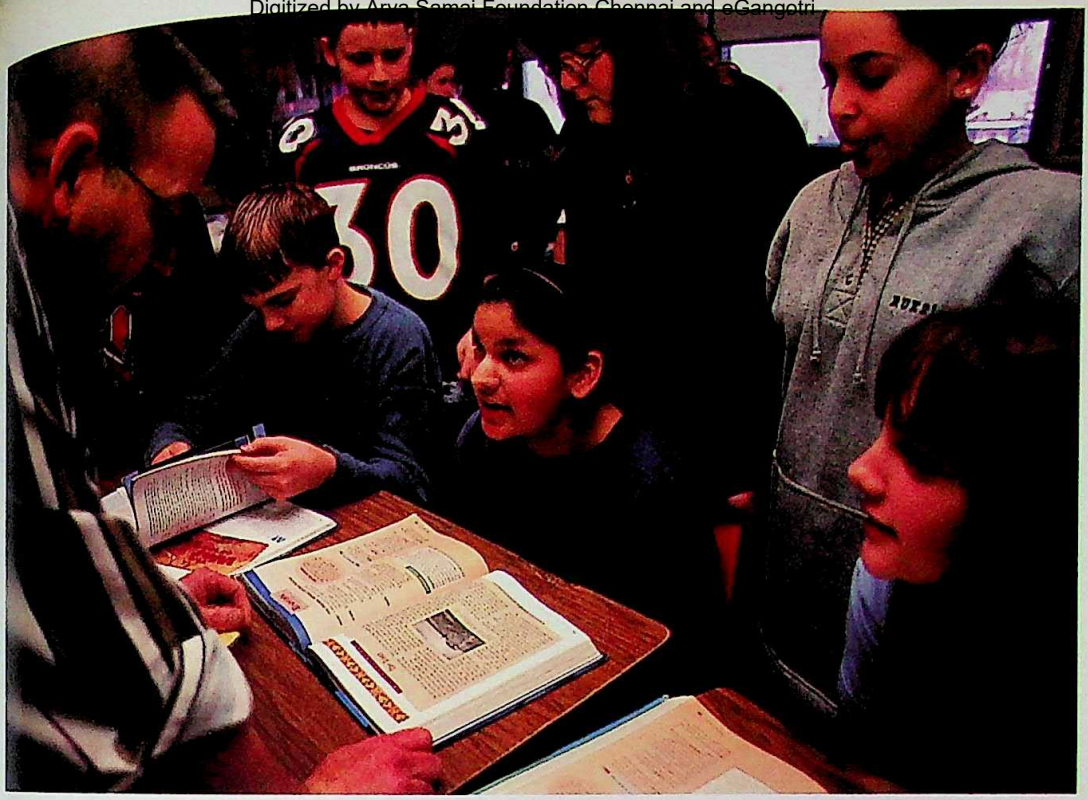

of data. Your entire genome will easily fit on the hard disk in your desktop PC."

Understanding human biology as a quantity of data requires a strange, steely new kind of science. The Sanger Centre is not a laboratory in the traditional sense. It is a factory. In back rooms gleaming machines whir through regimented tasks. The needle-tipped arm of a robot sampler plunges down to sip a tiny portion of DNA from a grid of samples, then swings headlong to the other end of its range of motion and spits the solution into another receptacle. Across the hall I am shown the heart of the facility: 80 automated sequencing machines running at full capacity 24 hours a day, seven days a week. Another 50 are humming away in other rooms. Hundreds more are pouring out human code at other genome centers in the United States.

"This is the most important organized scientific effort that humankind has ever attempted," says Francis Collins, director of the Human Genome Project at the National Institutes of Health outside Washington, D.C. "It dwarfs going to the moon."

"People have trouble understanding the sheer magnitude of this work," says Craig Venter, head of Celera Genomics in Rockville, Maryland, a private company challenging the government effort for the right to claim discovery of the code of human life. According to his estimate, "There are roughly three and a half billion letters in the human genome. If it were a book and you could read ten letters of it every second, it would take 11 years to recite the whole text."

Even if we had 11 years to spare, a simple recitation of the code would give no hint of the way it makes a human life. Instead of thinking of the genome as a book, imagine it as a piano keyboard. Each piano key represents one gene. If you press down on a key, you hear a single note. That note corresponds to the protein that the gene specifies. If you press the key again, you will hear the same note, and again, monotonously, every time the key is played.

But if you have lots of keys, you can make music. Just so, our various cell types play upon the immense keyboard of the genome: They combine notes, playing some genes together as chords, tripping several together in a phrase, gathering bundles of notes to create the complex and wonderful effects that find expression in our biological being. Just as a pianist doesn't play all the keys in every piece, only some of the genes get played in the cells of each organ. Sonata in the Key of Kidney.

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BLUE LIGHT helps rid a Mennonite girl of toxic levels of bilirubin, a blood product that her liver cannot break down, making her eyes yellow. The culprit: Crigler-Najjar syndrome, a one-nucleotide error in a recently identified gene. Half the cases in the United States occur among Pennsylvania's Amish and Mennonites, who may have inherited the mutation from one founding family 16 generations ago. Soon this girl may begin a new gene-therapy trial.

The Brain Fantasia. Variations on the Theme of Gonad. Beautiful music, all of it. But think what can happen to a piano concerto if an important key sticks or sounds the wrong note when struck. Such a flaw will ruin every passage where that key is played.

In some cases it will destroy the music entirely. In the United States one child out of every 3,900 is born with cystic fibrosis, the most common deadly hereditary disease among Caucasians. The mucus in the lungs is abnormally thick, leaving the child vulnerable to repeated infections that erode the lungs' tissues and eventually the ability to breathe. Half of all sufferers die before their 31st birthday.

Ten years ago researchers in Toronto and at the University of Michigan traced the cause of the disease to a defective gene on chromosome 7. Such single-gene defects account for 3,000 to 4,000 other inherited diseases. Sickle-cell anemia is caused by nothing more than a substitution of a T for an A in the spelling of a gene governing the manufacture of the hemoglobin protein in red blood cells. Huntington's disease, the lethal degenerative condition of the brain that killed folk singer Woody Guthrie, occurs because a gene near the top of chromosome 4 contains a series of up to 85 extra "stutters" on the letters CAG, playing like a scratched record on a turntable.

It took more than a decade for scientists to track Huntington's disease to a specific gene—and it was an easy target. Most diseases, including the common killers like cancer and heart disease, stem from disruptions in the interaction among several genes and between genes and the environment. When you hear about the discovery of the gene for breast cancer, Alzheimer's disease, or some other ailment, what is usually meant is that someone has found a gene implicated in some forms of the disease, in some people, some of the time. Rooting out the genetic component in most illnesses is still a dauntingly difficult task. Luckily it can be a little less daunting in some parts of the world than in others.

A FEW DAYS after visiting Cambridge I am in Iceland's West Fjords riding along the edge of the world in a red Toyota Land Cruiser. Falling snow has begun to slicken the road, and I am trying not to look down, where a hundred feet below an angry dark tongue of the Arctic Ocean licks at a black beach. At the wheel is a soft-spoken, fast-driving orthopedist named Thorvaldur Ingvarsson. We are on our way to see some of his patients who are afflicted with osteoarthritis, a painful, crippling disease of the joints. In his wool sweater and glasses Thorvaldur could be just a quiet country doctor making his rounds in a remote corner of an isolated country. But he isn't interested in merely treating people with osteoarthritis. He wants to find its cause. With help from a formidable ally—the entire population of Iceland, living and dead—he is getting close.

"This disease is five times as common in Iceland as in most other countries," he tells me. "People think it is because of the hard work here, the fishing and the farming. My theory is it is not the job. It is the genes."

In 1987 a woman who had already had one

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BORN OLD: Dolly, the first mammal cloned from an adult cell, bleats at Scotland's Roslin Institute. Dolly was a milestone in efforts to turn farm animals into living drug factories. Some sheep have been genetically altered to produce a protein in their milk that is being tested in Northern Ireland to help cystic fibrosis patients breathe easier (opposite). As for Dolly, her cells may have aged as much as her "parent."

hip replacement and would soon need another came to Thorvaldur. She mentioned that ten of her sixteen siblings also had the disease.

"It was unbelievable," he remembers. "I looked up all the people who had received hip replacements in Iceland. In the one extended family this woman belonged to, there were records for 700 cases of osteoarthritis of the hip stretching back five generations."

Using family histories to tap the roots of human disease is standard practice in genetics. If you can ferret out the difference in DNA between sick people and their healthy relatives through several generations, you will have a big leg up on knowing what is making them sick. Unfortunately there is rarely a single genetic flaw behind every case of an inherited disease because such flaws arose in the distant past in different places. In most populations, genes have been shuffled and reshuffled through generations of migrations and interbreeding, making the search for a link among the diseased a murky business.

Look into the Icelandic gene pool, however, and you can see right to the bottom. The country was originally populated in the ninth century by just a few hundred Norwegian Vikings and a handful of Celts. Since that time few immigrants have been tempted to its desolate shores. A series of calamities through the centuries—plague, smallpox, and volcanic eruptions leading to massive famine—further reduced the genetic muddle.

To make matters even better for geneticists, Icelanders have always had a passion for genealogy; almost everyone knows the names and birthplaces of their ancestors four or five generations back, and meticulous written records extend all the way back to the original settlers. Most genetic diseases in Iceland can thus be traced to mutated genes in one or two individuals in the past few hundred years, making the search for errant genes much easier than in other countries.

"Every one of us is walking around with replicas of the genomes inherited from the

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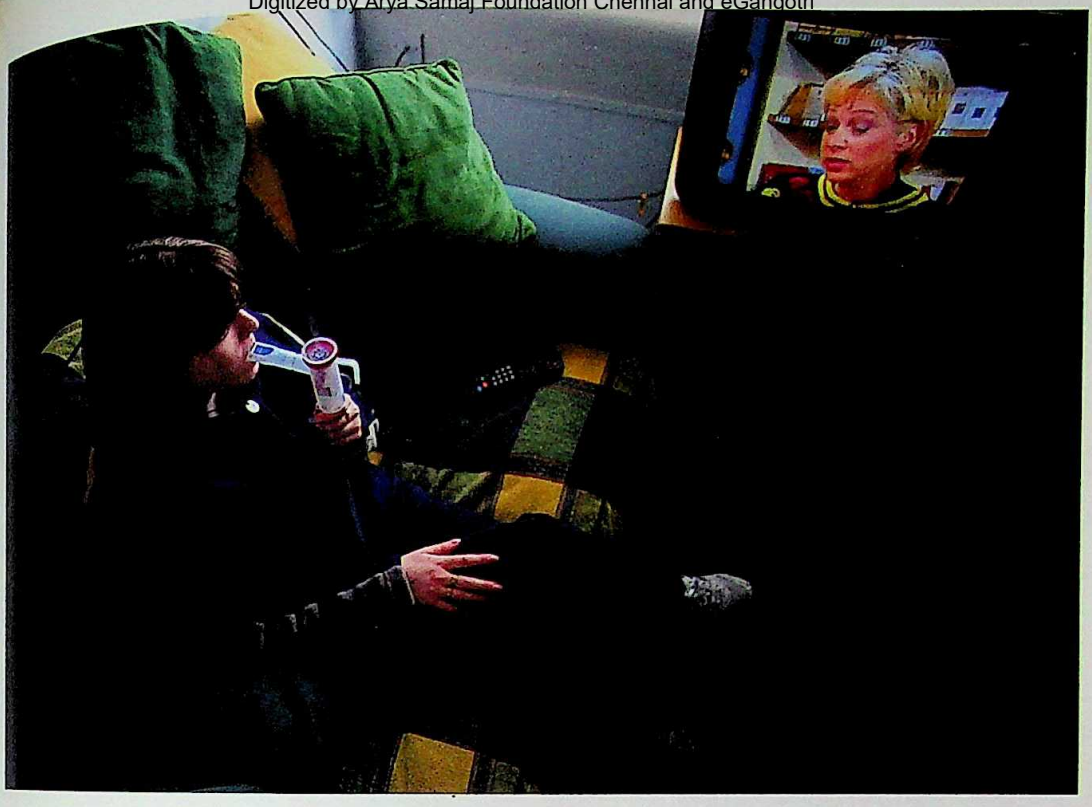

settlers," says Kári Stefánsson, head of DeCode Genetics in Reykjavík, which is exploiting Iceland's genetic simplicity to hunt for disease genes. "This is reincarnation in a literal sense."

With help from Thorvaldur, DeCode geneticist Stefán Einar Stefánsson has tracked down the chromosomal location of the gene responsible for most of the hip replacements in Iceland. (The defective gene was brought to Iceland in the middle of the ninth century by one of the original immigrants.) Soon Thorvaldur and Stefán hope to capture the code of the gene itself.

That information could be used to develop diagnostic tests for osteoarthritis not only there but also abroad. Icelanders have been isolated for a thousand years, but their genes derive from the same ancestral pool as other Europeans—and back in time to other populations as well. In the long run knowing the gene's code could provide the missing key needed to design a drug that attacks the disease at its source, ending the need for joint replacement in thousands of patients all over the world.

Near the tiny fishing village of Tálknafjördur, Thorvaldur and I stop at the farmhouse of Ragnheidur Magnúsdóttir, who has already had both her hips and knees replaced. Before she became ill, she welcomed the hard work needed to help her husband run the farm. Now all she can manage is to cook for the farmworkers, clutching the stove for support.

"You can't behave like you did before," she says. "I want to do everything I can to help find a solution to a disease like this."

Ragnheidur has already done something: She has given her blood to DeCode. Last year, after fractious debate both here in Iceland and among scientists abroad, Iceland's Parliament passed a law giving a company, expected to be DeCode, exclusive rights to create and maintain a gargantuan database containing the country's health records. Eventually this database will be combined with Icelandic genealogical records and DNA profiles. Integrating this information into a single database will make it much easier to link diseases and propensities for disease to particular genetic patterns. Most Icelanders supported the bill.

But in the minds of DeCode's critics the database is an ominous development. What does it mean when a single private company is licensed to sell the genetic legacy of an entire population? The identities of the individuals in the database are supposedly protected by elaborate encryption, but what happens if there are leaks? *(Continued on page 64)*

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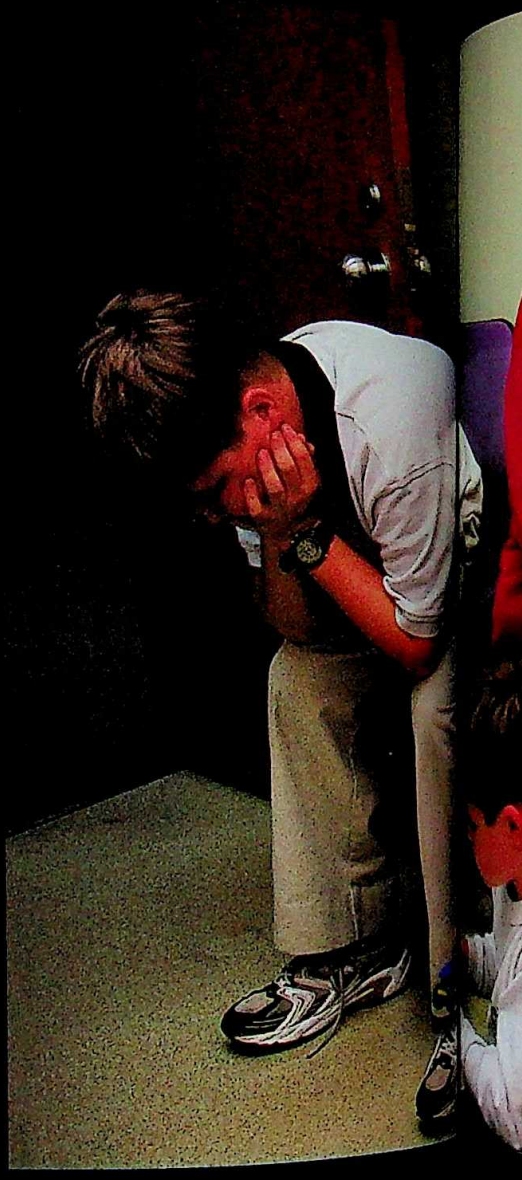
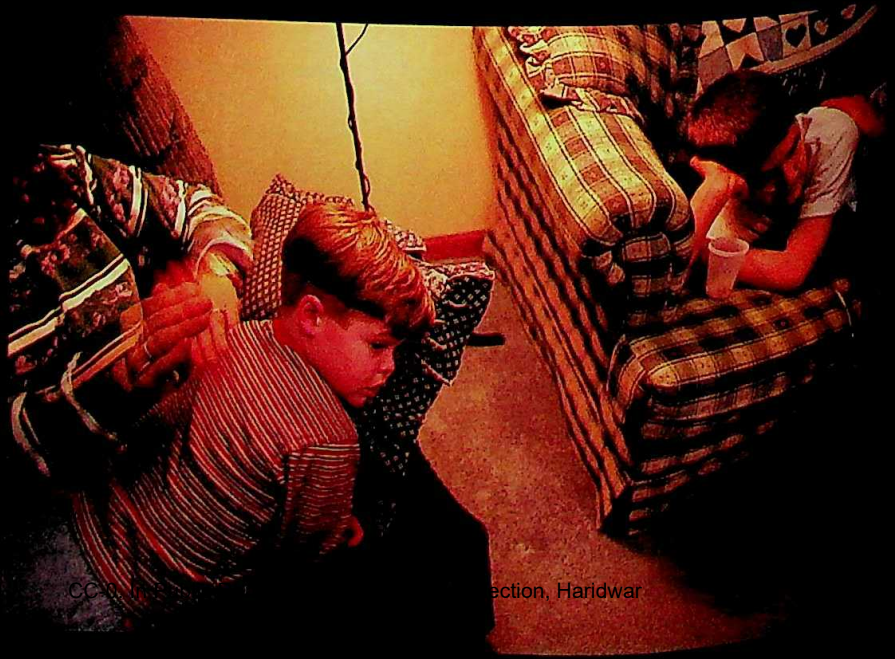
Cystic Fibrosis: A Hidden Killer

Three of Kathy and Jack McGowan's five children have cystic fibrosis (CF), the most common deadly genetic disease in the U.S. Its cause is a defect in a gene that controls the balance of salt in lung cells. Mucus builds up, fostering infections that can be lethal. At present, one of every two CF sufferers dies before age 31.

While John (right, at far right) waits for a lung capacity test (below right), Kathy makes an entry in a notebook that records details of treatment. At home (below) the McGowans pound Matt's and John's backs to loosen mucus in their lungs.

To develop CF, a child must inherit the defect from each parent. One in 31 Americans is a carrier; with each pregnancy a carrier couple has a 25 percent chance of having a child with CF. After John was diagnosed, the McGowans kept having children, trusting in faith. Today, options have increased, including *ex utero* testing of eggs.





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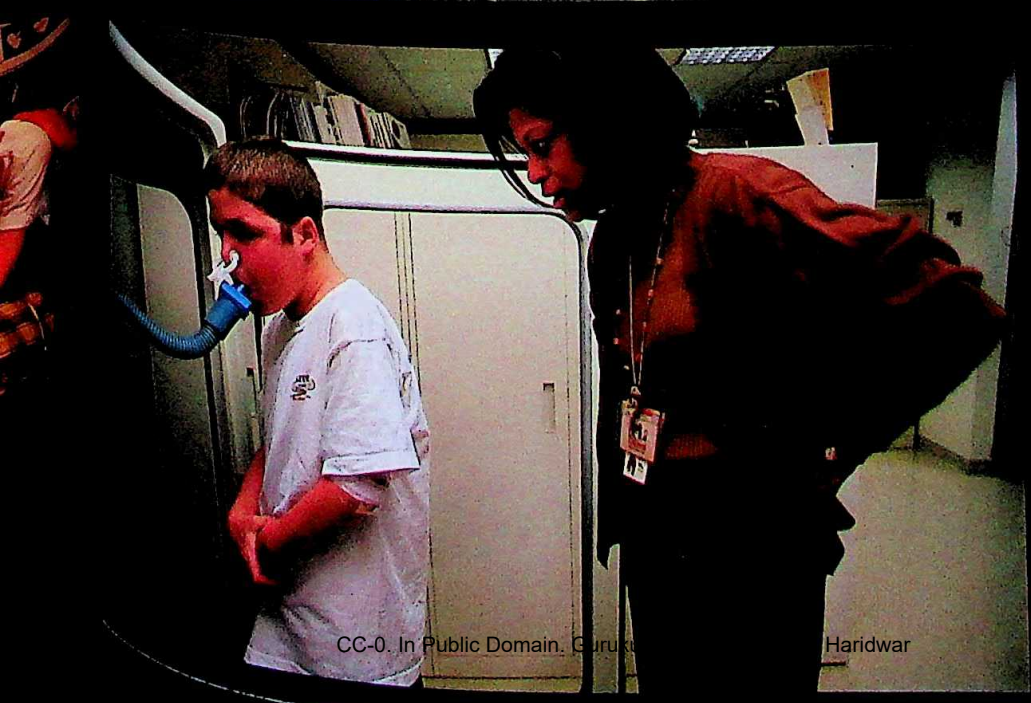

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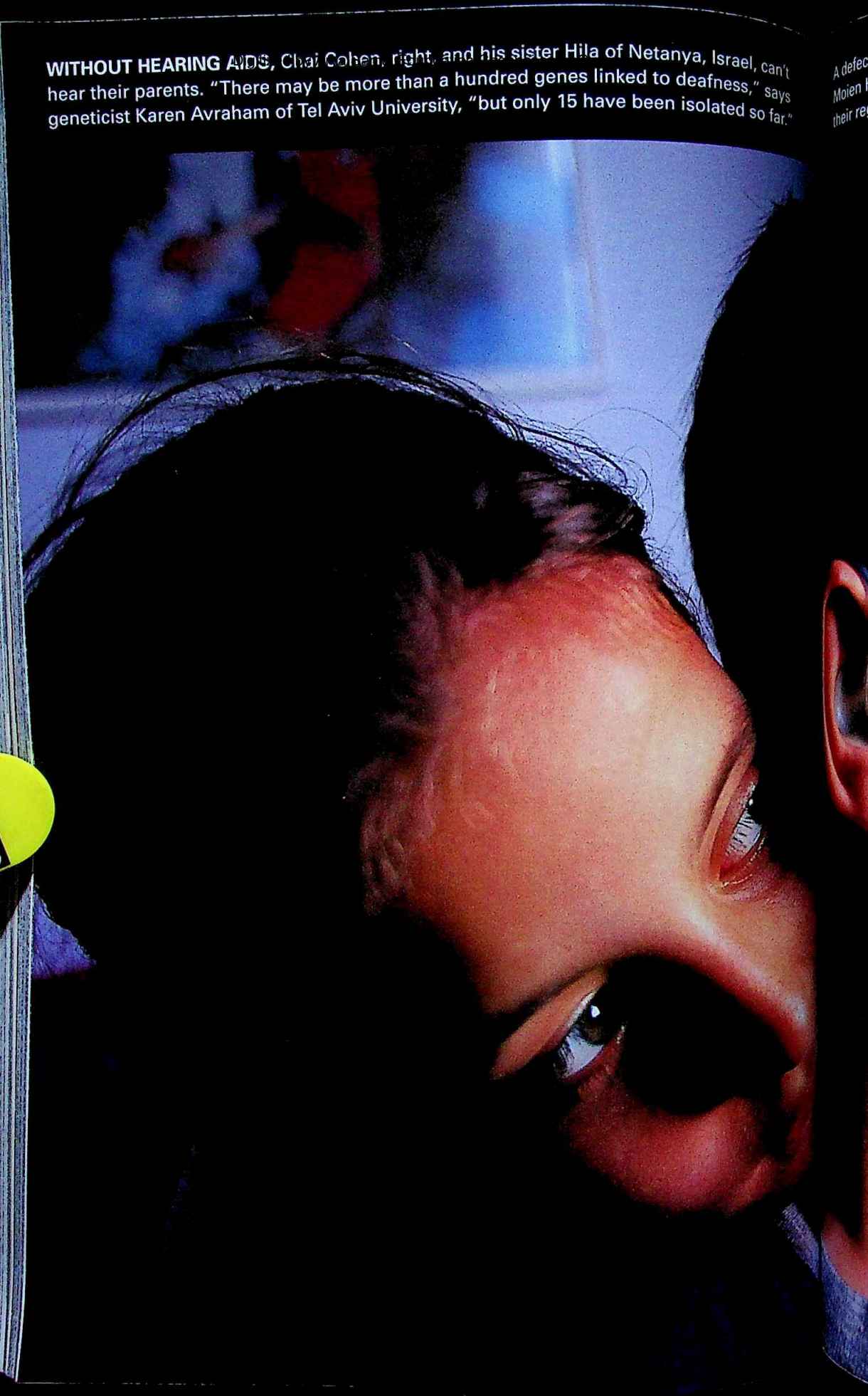

WITHOUT HEARING AIDS, Chai Cohen, right, and his sister Hila of Netanya, Israel, can't hear their parents. "There may be more than a hundred genes linked to deafness," says geneticist Karen Avraham of Tel Aviv University, "but only 15 have been isolated so far."

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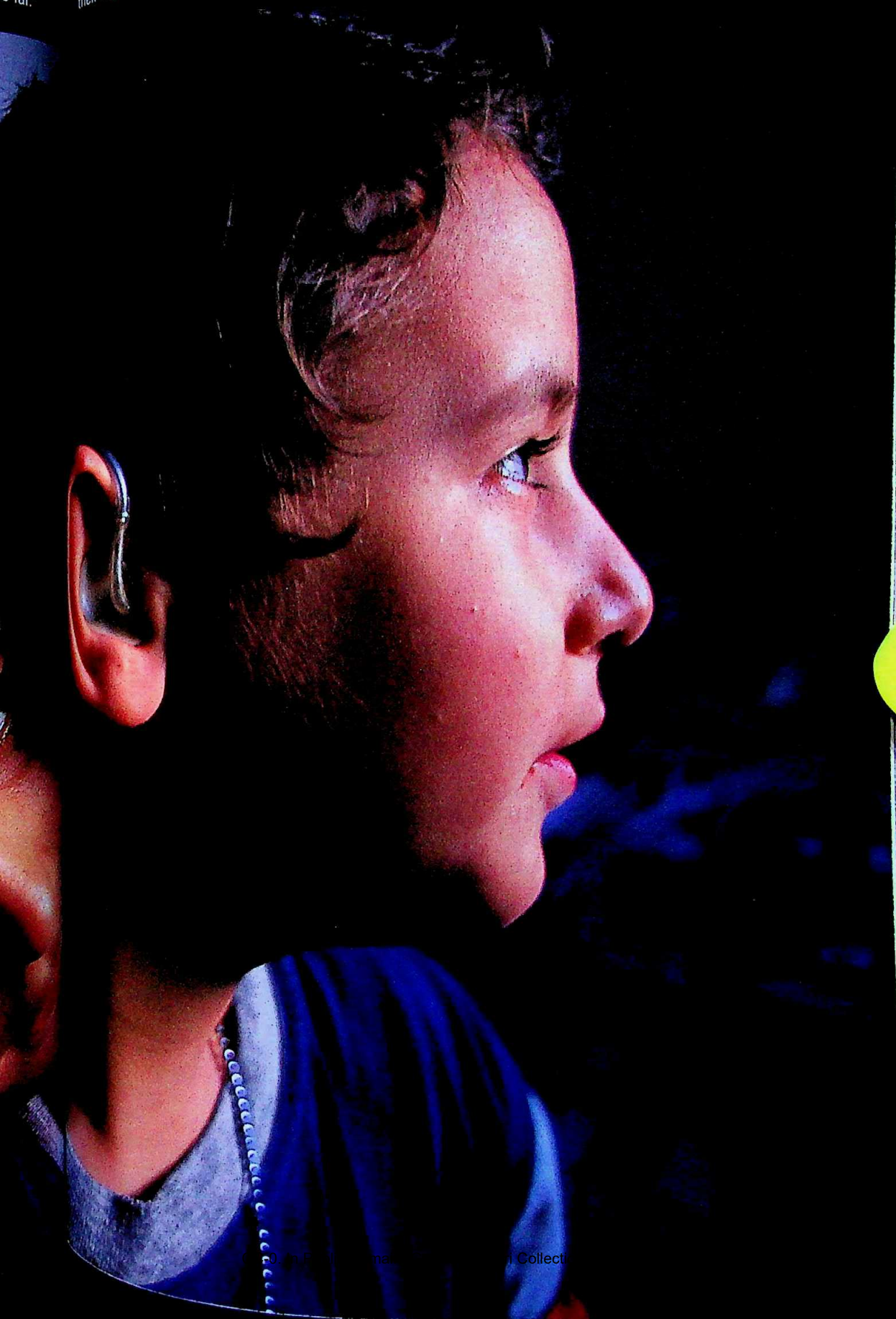
A defect in just one gene can cause hearing loss. Avraham and Palestinian researcher Moien Kanaan of Bethlehem University hope to find the genetic causes of deafness in their region, where in some places hearing impairment affects as many as one in ten.



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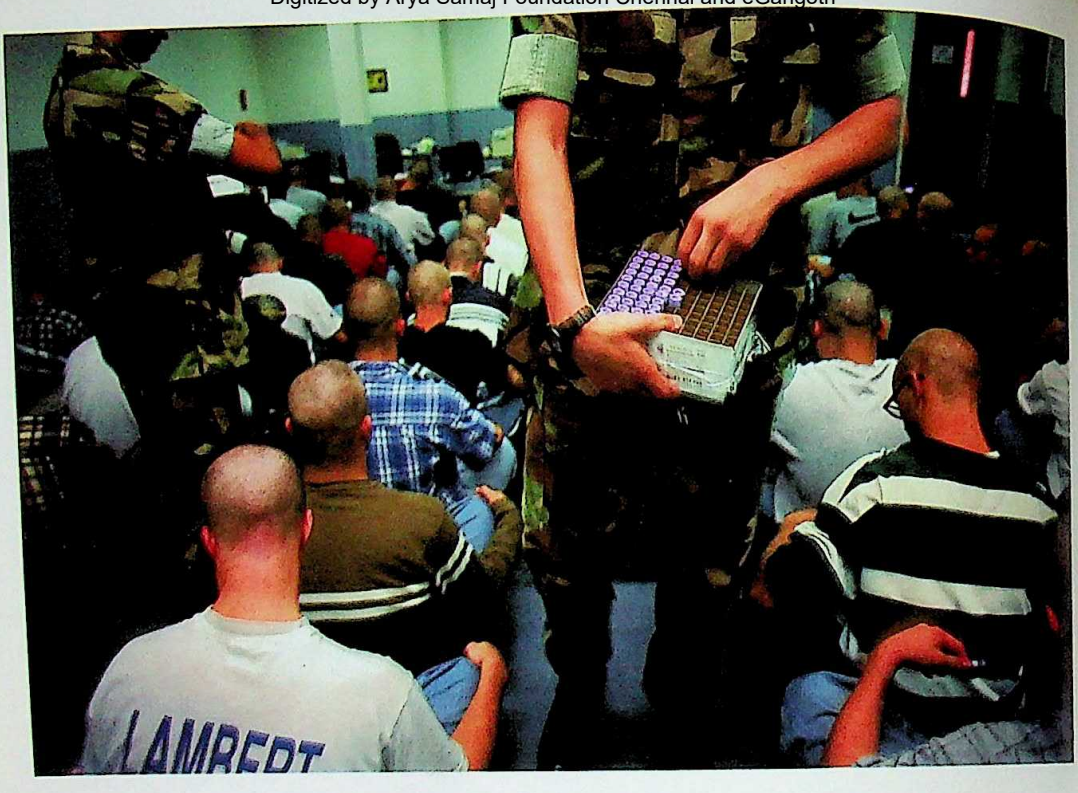

MARINE RECRUITS give up more than hair at boot camp on Parris Island, South Carolina. Blood samples are collected and sent to a warehouse in Maryland (opposite) to be stored in freezers until DNA is needed to identify combat or accident victims whose remains are too mutilated for conventional analysis. DNA from the armed forces' archive of 2.75 million specimens has been used to identify 192 bodies.

Can an Icelander face the loss of a job because someone finds out he has a gene predisposing him to alcoholism or schizophrenia? Furthermore, DeCode plans to market its information to anyone who can pay the price, including foreign pharmaceutical firms and health insurance companies. What happens if my health insurance company or yours discovers that we carry a gene that in Iceland causes osteoarthritis or diabetes?

"What worries me about this research," says Thorvaldur, "is what to do with the results."

I DON'T HAVE TO WORRY about the results of my GeneChip test at Affymetrix because its fate has been decided in advance. Two days after the DNA is extracted, Kyle O'Connor and I are sitting before a computer terminal displaying a grid of bright orange, green, and blue squares. Standing beside us is Anne Bowdidge, the public relations director who has been patiently showing me around—and is also making sure I don't see too much. The colored grid represents 1,500 places along my chromosomes where variations of a single letter in the genetic code occur. I click the mouse button randomly on an orange spot on the grid and up pops a window telling me that at this particular address on my genome I have a G where other people might have a C.

"I'm not sure you're supposed to know that," says Anne. "We don't want any of this coming back to haunt you."

Neither do I. In most cases such variations, called SNPs, or "snips" (shorthand for "single nucleotide polymorphisms"), don't make any difference in the functioning of the individual. They are highly useful, however, as markers, like landmarks on a map, for any genes that may be discovered near them that do matter. I have been told that no diseases are known to be associated with having one snip or another at any of these 1,500 spots. But there may be, just as soon as researchers start using the chip to look for them. Because snip chips can scan

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such a great swath of genetic terrain, they may eventually be able to untangle the roots of diseases involving more than one gene. At that point the results of my test *could* start to matter, possibly a great deal.

For that reason Affymetrix and I have agreed that the data will be destroyed after I finish viewing it on the screen. But let's suppose the information were to survive. Who should have access to what it might say about my genetic condition? Affymetrix? My HMO? Me? How would knowing such information affect the way I conduct my life?

"It all depends on how powerful the information is," says Hank Greely, a law professor specializing in genetics at Stanford University, just up Highway 101 from Affymetrix. "Look at Huntington's disease. It is invariably fatal after a horrible decline. If you tell somebody they've got that variation of the gene, you've given them a hell of a lot of information."

Such knowledge may be too much to bear. A diagnostic test for Huntington's disease has been available for years now, but most people at risk decline to take it. Legislation might protect them against genetic discrimination in health insurance and employment, but what about the psychological costs of knowing too much about one's genetic endowment?

"The real implications of genetic testing are familial," says Greely. "Is your wife going to divorce you when she finds out you have the Huntington's disease variation? How will the parent feel who gave it to you? How do you tell your kids you may have given it to them?"

Greely is quick to point out, however, that a rare disease like Huntington's, where a bad gene determines an inescapable fate, is not the right model for understanding the impact of most genetic information. In the overwhelming number of cases, genes only predict susceptibility to diseases, not certainty. That kind of information, Greely explains, isn't of great interest to health insurance companies or employers because they already have better ways to predict who is likely to get sick and who isn't. The number of times I saw my doctor last year provides a far more powerful forecast of how much I'll cost my HMO this year than most anything my snip chip would reveal.

On the other side of the balance is all the new knowledge of the genome that can be put to good use. If you carry one of six genes known to be involved in colon cancer, for example, you have up to a 100 percent chance of developing the disease—if you don't know you are at risk. If, on the other hand, you discover through a simple blood test that you are

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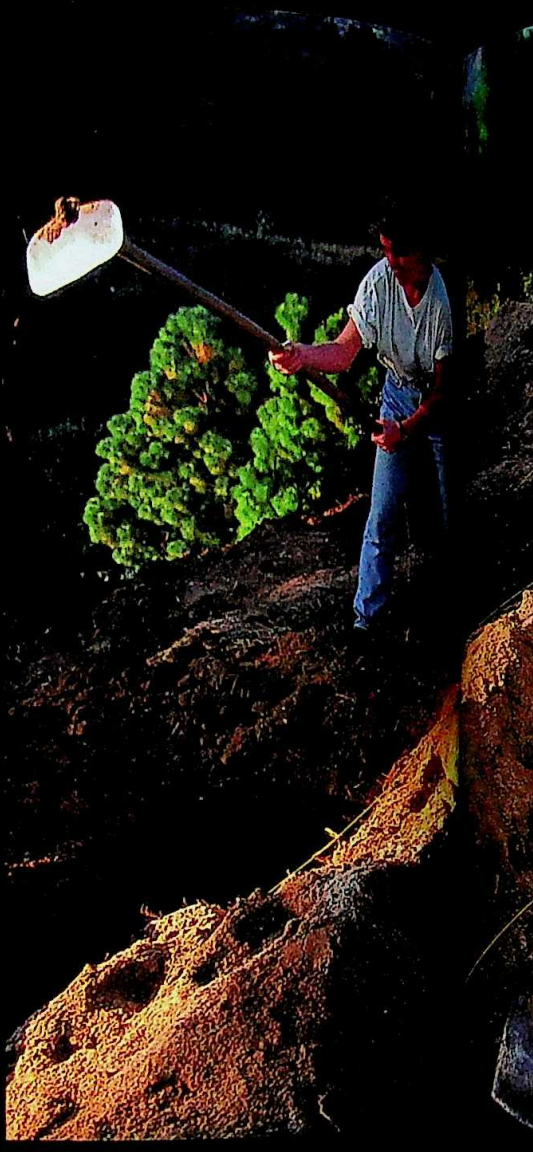
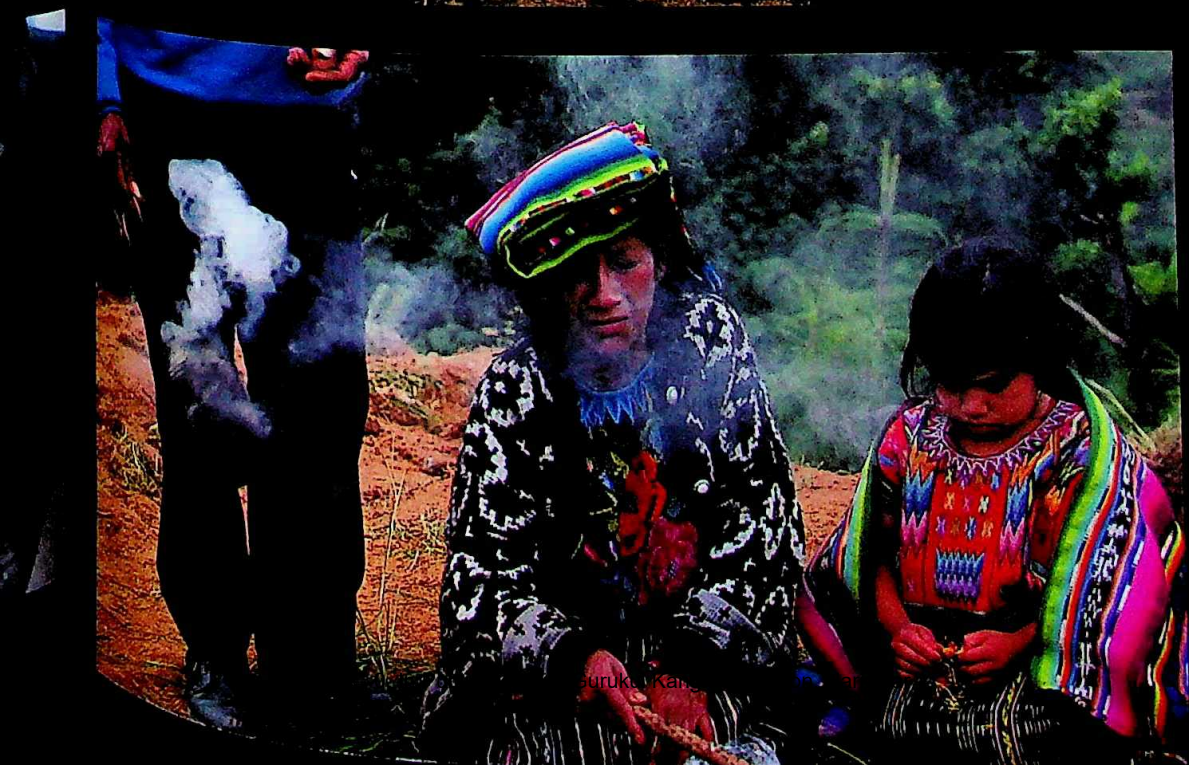
Genetic Justice Comes to Guatemala

Long after a life's violent end, geneticists like Michele Harvey-Blankenship (right, with hoe) of the University of Washington can use DNA to tell a victim's story and bring criminals to justice. More than 200,000 Guatemalans disappeared or were killed in decades of civil war. Michele was called in to corroborate eyewitness reports of political executions in the 1980s.

Trenches are dug near suspected mass graves. If remains are found, the team seeks the body's most durable DNA repositories—teeth and bone. An undamaged tooth's interior can retain testable DNA for thousands of years. Mitochondrial DNA, inherited from mothers, is compared with DNA from surviving maternal relatives. Michele has identified bodies in five mass graves in Guatemala, findings that will help rewrite history. "No one can argue that these killings didn't happen," she says. To a Maya family (below right), recovering remains of loved ones has an even greater meaning: Until properly buried, they believe, their dead are in a state of unrest.





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a carrier, you can elect to have regular check-ups and remove any polyps that develop in your colon before they become malignant. In that case your chance of getting the disease falls close to zero. So now your genes aren't deciding whether you live or not. You are.

"Genes are not fate," says Greely. "Usually. For most of us."

With all the emphasis on genes that cause disease, it is easy to forget that the genome is the recipe for life, not death. Behind the colored array of my snip chip may lie information on how I metabolize the contents of a tuna sandwich, why my eyes are blue or my hairline is not where it used to be, or why I'd rather ski than play golf.

We know genes play a role in influencing behavior and personality; studies showing that identical twins raised apart share an uncanny number of behavioral traits back that up. But so far attempts to tag a particular behavior to a particular gene have been problematic because such complex behaviors necessarily involve the cooperation of many genes. On the genomic piano, behaviors and personality traits are not single notes but intricate compositions.

I linger a little while longer over the image on the screen, but the exercise has run its course. It is unlikely that the information on this chip, even if I knew its meaning, would say anything about why I am absentminded, sleep poorly, or chose to be a writer. But these 1,500 snips offer a hazy glimpse into the genome. More snips are being discovered every day. Within a year a rough draft of the complete genetic code of a typical human being will be posted on the Internet by Celera Genomics, the Human Genome Project, or both for anyone to explore. Celera's Craig Venter envisions a time soon when family doctors and even individuals can log on to a website and test specifics of their own genome against a vast database of knowledge about disease, behavior, diet, and drugs. What hypertension drug targets my genetic profile of the disease? What kind of fats do I have trouble metabolizing so I can know to avoid them?

"Imagine a day when these technologies are more advanced and more available," says Affymetrix's Steve Fodor. "People can begin to look for themselves at how their genetics are likely to affect everything from their eating habits to the kind of perfume they choose to wear. We think genetic information will give people more control of their lives, not less."

As arranged with the Affymetrix lawyers, when I finish with the image of my genome, I drag the data file to the trash bucket on the screen and delete it. I had anticipated a sense of relief when this testimony to my genetic identity was safely silenced. What I hadn't counted on was a twinge of regret.

COMPANIES LIKE Affymetrix and Celera are prospecting the genetic code for glimpses of the future. Far away, on a hillside in the tiny, forlorn Guatemalan village of Tzanimacabaj, a young geneticist named Michele Harvey-Blankenship is using DNA to dig up the past. On my right, dressed in blue jeans and a white T-shirt, Michele shovels dirt into a wheelbarrow and dumps it over the edge of a wooded slope. On my left a villager named Juan Calel Mateo tears into the ground with a broad-bladed hoe. Somewhere beneath its cutting edge lie the bones of his father.

Like thousands of other Maya Indians, Mateo's father was killed during the long Guatemalan civil war, his body heaved into a hole in the ground with half a dozen other innocents from this village. In the Maya belief system those who are buried without proper ceremony are not truly dead. They have no peace. They have no identity.

That is why Michele Harvey-Blankenship is here. Based at the University of Washington in Seattle, Michele specializes in using DNA to identify victims of genocide and other human rights violations. Working with the Foundation for Forensic Anthropology of Guatemala, one of only a few organizations in the world performing this arcane and grisly task, Michele reunites the remains of the disappeared with their living relatives. She has worked in Bosnia, Argentina, El Salvador, and several times here in Guatemala. The work is not just for the comfort of families and the souls of the disappeared. The ability to bring the perpetrators of genocide to justice often depends on having an identified victim.

"We try to reconstruct a skeletal biography of the person through traditional forensics," says Fredy Peccerelli, the foundation's indefatigable young director. "But the most we can

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ANCIENT JEWISH RITUAL, the redemption of the firstborn son requires payment to a Cohen, far left, a member of a priestly clan that traces its paternal lineage back to Aaron, the first priest. Researchers have found genetic markers on the Y chromosome that may have been passed from father to son for more than 100 generations.

do is get a tentative identification. With DNA that changes to a positive identification."

Trailing behind every one of us as we move through our days is an invisible wake of identity. Sometimes, someone's wake catches up to him. Think of the bloody glove or the stained Gap dress. In the last decade DNA fingerprinting has become an indispensable tool in investigations of murder, rape, and other crimes where the offender might leave at the scene a litter of personal bar codes in the form of hair, skin, and body fluids.

Last year the FBI opened a national DNA database of people convicted of certain serious offenses. England already has a DNA database of everyone convicted of a crime since 1995, as well as of suspects in unsolved cases. Because of these databases the guilty will be convicted more often and, more important, the innocent will be exonerated.

The more powerfully DNA can link a person to his past, the more people will worry about how that power will be abused. Last December the mayor of New York said he'd have "no problem" if all newborns in the city were to have their DNA fingerprinted. Does his city government, or mine, have a right to a record of my genetic identity? Will this wonderful tool for solving crime make suspects of us all?

Such ethical dilemmas are real, but they belong to a world far from this mangled hillside. The only people who need to fear DNA tests on these bodies are the ones who put them here in the first place. The chief suspect, a former paramilitary patrolman in the village, is in hiding close by. He has done everything possible to impede the excavation, including threatening the villagers.

If all goes well, we will find the skeletons, and Michele will take samples of bone and teeth back to Seattle. She will then extract a certain kind of DNA called mitochondrial DNA, which is plentiful even in badly decayed bone. She will also take back blood samples from the deceased's presumed kin and from unrelated members of the community as well. If DNA can be obtained from the victim and his relatives, it will show identical sequences

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PRAYER SHAWLS cloak Cohanim blessing supplicants at Jerusalem's Western Wall, an inherited duty that is theirs alone. Would-be Cohanim have contacted the discoverers of the clan's genetic bond in hopes of proving that they belong—as have some members,

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perhaps hoping to shed certain restrictions. Rabbis are pleased that science seems to support the Cohen tradition of a common ancestor, but some worry about a litmus test for individuals. For now, however, ancient custom still determines Cohen status.

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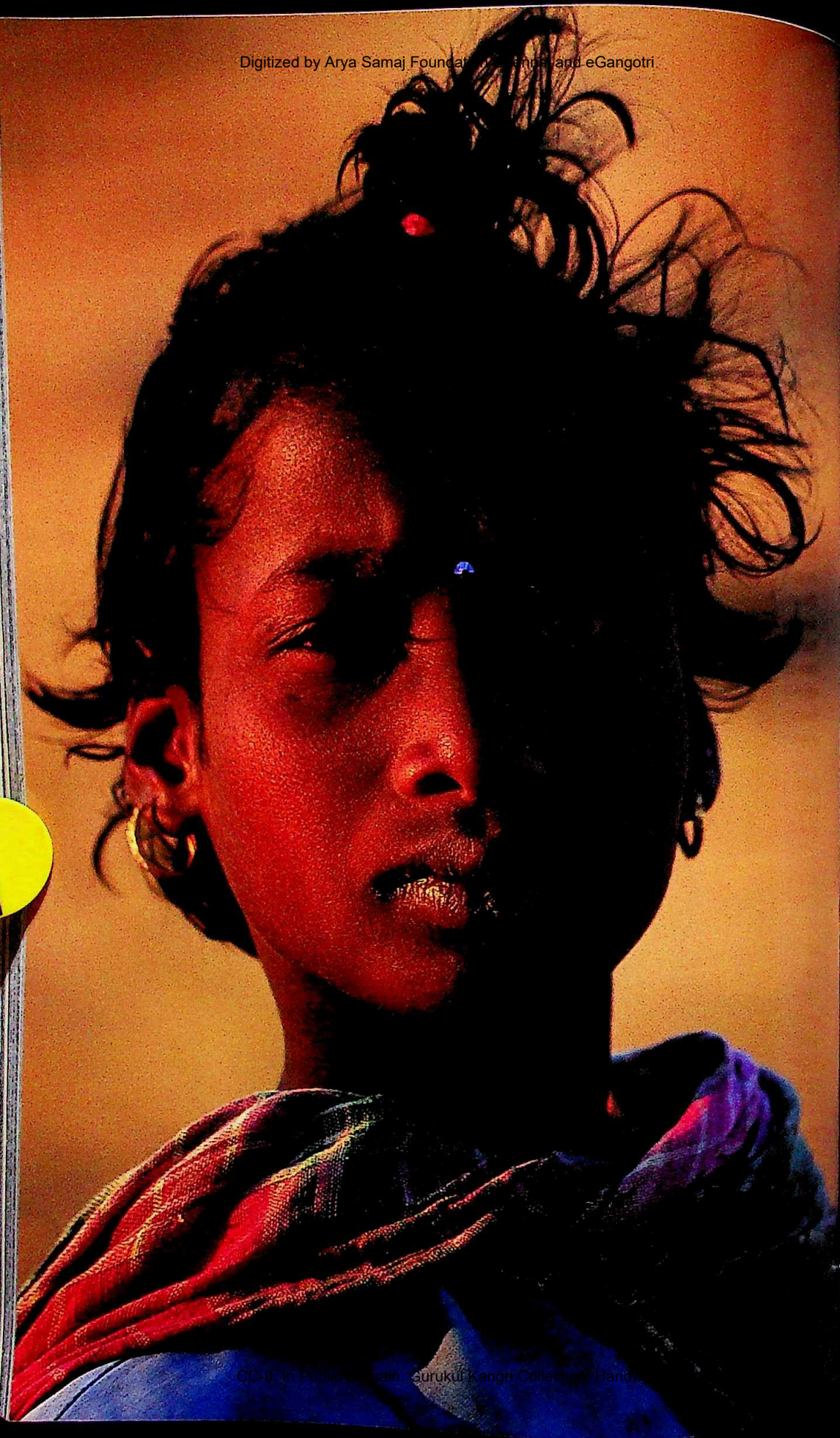

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not seen elsewhere in extensive databases in Michele's lab.

"Basically it's just taking two population sets and comparing them," she says, pausing to lean on her shovel. "The living and the dead."

Unfortunately here in Tzanimacabaj all doesn't go well. Four days of ferocious digging fails to locate the bodies. The villagers and crew are deeply disappointed, but there is no time to mourn this setback. We return to Guatemala City, where some of the hundreds of skeletons already exhumed from other sites are laid out on tables in the residential garage that serves as a laboratory, awaiting analysis.

The next day I find Michele bending over a skull, pulling out a tooth with a pair of pliers. Written in black ink on the cranium is the catalog number SAQ IIIE-FI-2. It indicates precisely which specimen this is and which massacre it came from. But it is not quite the same thing as a name. Convicting someone in court of the murder of SAQ IIIE-FI-2 will be difficult. It is hard to pray for SAQ IIIE-FI-2 if you are his mother. Michele slips the tooth into a resealable bag to take back to her lab.

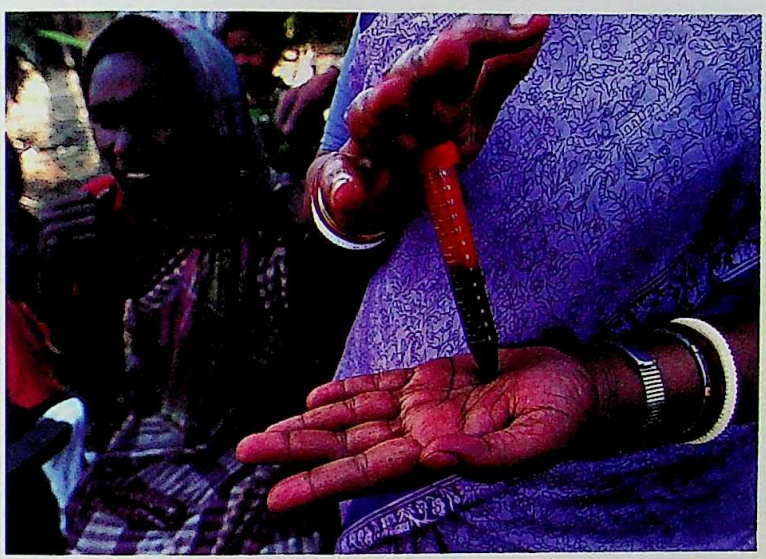
"There is a saying in forensic anthropology that every skeleton has a voice," says Michele. "We are using DNA to express that voice."

A few days after I return from Guatemala, an eagerly awaited package arrives for me from Oxford, England. Inside is a small conical brush. Following instructions in the letter enclosed, I rub the brush gently on the inside of my cheek for a minute. I place the brush carefully in a provided envelope and post it back to my correspondent, Eileen Hickey, a geneticist at the University of Oxford. If the DNA on the brush is suitable for analysis, I will soon be reunited with an ancestor across an astonishing expanse of time. It strikes me as even more astonishing that this introduction can be conducted through the mail.

Hickey and her colleagues use mitochondrial DNA to sort out when and how the ancestors of modern Europeans first populated the continent. Unlike DNA in the nucleus of the cell, mitochondrial DNA is inherited only from one's mother. The letters of its code are thus passed down unmixed and unchanged from one generation to the next, except for random mutations that rarely affect its function. Because these mutations occur at a known rate and much more frequently than in nuclear DNA, mitochondrial DNA can serve as a clock to time events in the distant past. Compare any two persons' mitochondrial DNA, and the differences between them reveal how long ago they shared an ancestor.

As an American of European descent, I have a mitochondrial mother back in time whom the Oxford researchers might be able to identify. They have already come up with some remarkable findings.

According to Martin Richards, another geneticist on the Oxford team, the ancestors of living Europeans colonized the continent in three main waves. Most Europeans descend from a chain of mothers and grandmothers going back to the hunter-gatherers of the late Upper Paleolithic, some 11,000 to 14,000 years



THE FIRST INDIANS? Partha P. Majumder of the Indian Statistical Institute is using DNA from blood samples (right) taken from 30 different ethnic groups, including members of the ancient Oraon tribe (left), to build a model for the peopling of the subcontinent. His data suggest that the first populations arrived from Africa, then rapidly expanded and diversified. Genetic studies may solve riddles of human origins and migrations.

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A HEALING HAND, Icelandic surgeon Thorvaldur Ingvarsson (left, at left) replaced Ragnheidur Magnúsdóttir's hips and knees and co-discovered a genetic link to osteoarthritis, a disease that also struck ten of Magnus Gudmundsson's sixteen siblings (below left). A private company will soon win the right to survey Icelanders' DNA, making the nation a living lab. The novel project spurs hope for new cures and sparks debate about privacy and profit.

ago. About 10 percent trace their mitochondrial ancestry even further back, to the original colonization of Europe by modern humans some 50,000 years ago. The most recent group came out of the Levant about 8,000 years ago, following paths through central Europe and along the coast of the Mediterranean up to Britain. These people were early farmers, but they account for only one out of every five ancestors in the European gene pool.

"It is not true to say that the farmers overwhelmed the indigenous hunter-gatherers," says Hickey, addressing a piece of conventional wisdom. "Most of us who call ourselves Europeans will have had ancestors who were here long before the advent of farming."

A couple of weeks after mailing my DNA across the Atlantic, I find out that it falls squarely into the common baseline group against which more unusual variants are compared. Along with some 50 percent of Europeans, I descend from a hunter-gatherer woman who lived in the late Ice Age, perhaps a member of the Magdalenian culture that flourished in western and central Europe and is known best today for its cave art. She is not my only ancestor from that time, of course. But I'm glad to know her, and proud to have her living on in my genome.

TODAY SCIENTISTS all over the world are using mitochondrial DNA to re-create the migrations of other ancient peoples across Africa, the Americas, and everywhere between. It is important to keep in mind, however, that the exquisite diversity in our mitochondrial code that allows us to trace these events is a classic exception that proves the rule. In most of the rest of our genes—99.9 percent of them—every human being alive is exactly the same. Moreover, most of the variations in the remaining one-tenth of a percent don't bunch up into geographic regions or racial groups but instead are spread around the globe. Put another way, the snips and snippets of code that taken together make one person unique are scattered about in other unique genomes all over the world, binding all of us in a splendid tangle of interrelationship.

That tangle doesn't begin at our evolutionary branch but spreads up from far below. All the anatomical differences between human beings and chimpanzees, and even the hallowed uniqueness of human cognition, may in fact arise from slight changes in a few genes regulating fetal development.

Nine-tenths of our genes are identical to those of a mouse (a congruence particularly pleasing to geneticists, since lab mice are well studied and far more readily dissected than people). More than a third of the genes of the lowly nematode worm *Caenorhabditis elegans* are shared with the exalted primate *Homo sapiens*. Genomically speaking, even bacteria are our cousins in code.

The last and most powerful secret revealed by our genes, in fact, is the indisputable unity of everything alive. □

Check our online photo gallery at *www.nationalgeographic.com/2000/science/gene* for the stories behind Karen Kasmauski's pictures in this article.

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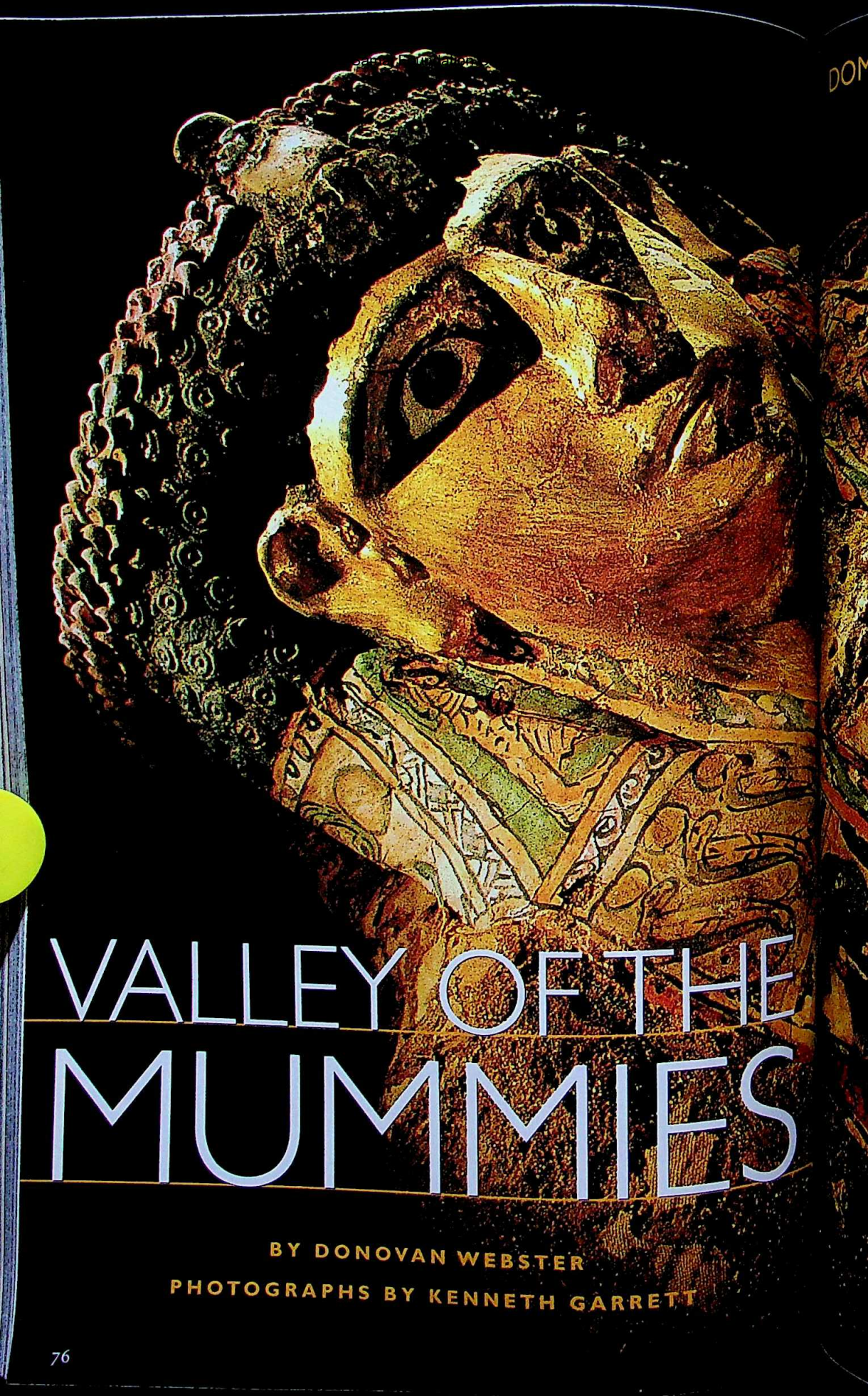
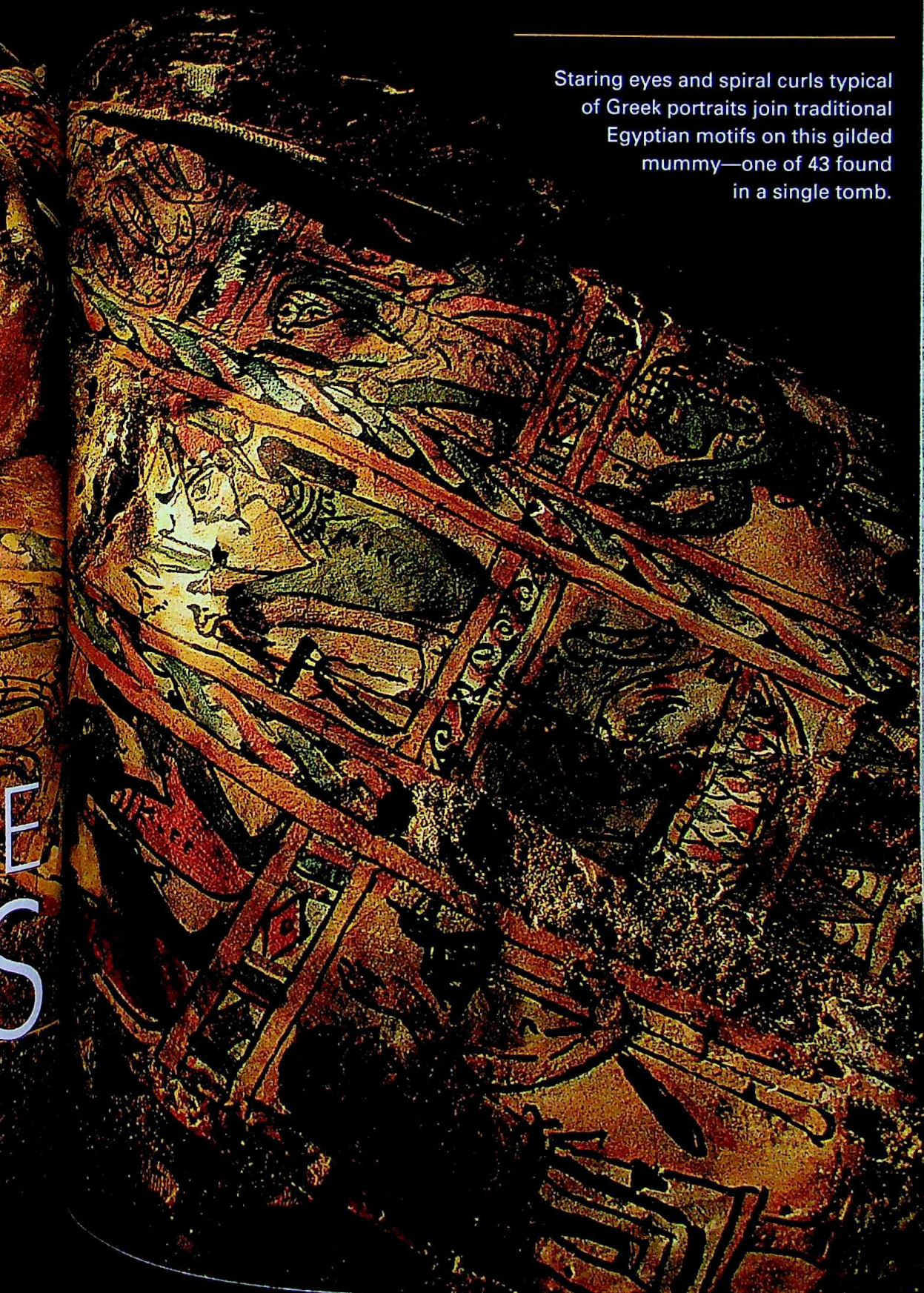


VALLEY OF THE MUMMIES

BY DONOVAN WEBSTER

PHOTOGRAPHS BY KENNETH GARRETT

DOMINATED BY GREEKS, THEN ROMANS, EGYPT ABSORBED THE ARTS AND GODS OF HER CONQUERORS. ARCHAEOLOGISTS HAVE DISCOVERED A VAST MUMMY CEMETERY IN THE WESTERN DESERT, WHERE HUNDREDS OF BURIALS RECORD ANCIENT CULTURES IN TRANSITION.



Staring eyes and spiral curls typical of Greek portraits join traditional Egyptian motifs on this gilded mummy—one of 43 found in a single tomb.

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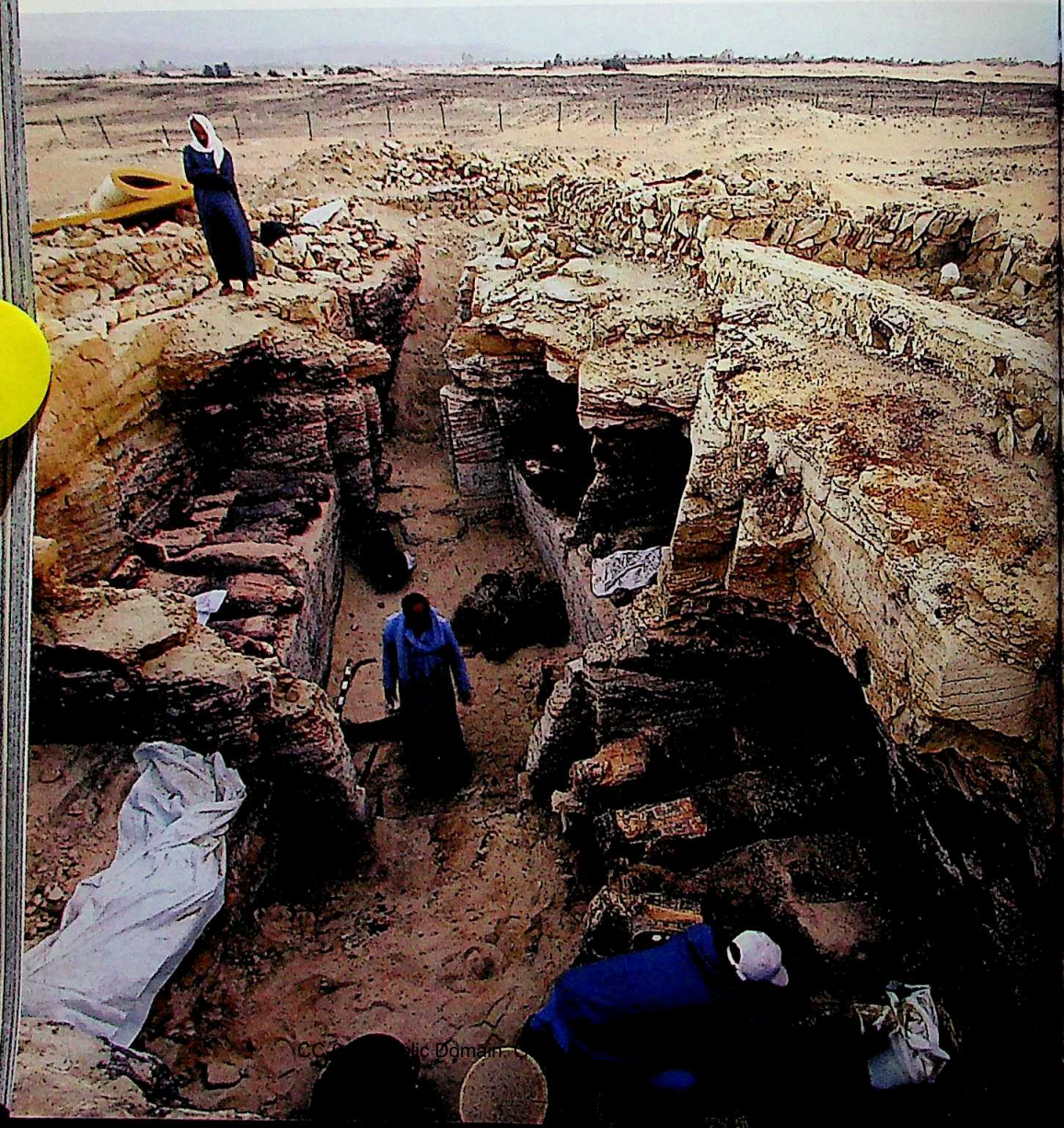
Sometimes in modern archaeology, despite its high-tech hardware and increasing knowledge of ancient cultures, the best tool any archaeologist can have is good luck. Well, that and a well-placed donkey's hoof. It's precisely this combination that led scientists to one of the largest concentrations of mummies ever found in Egypt.

The year was 1996. At an isolated oasis called Bahariya (Ba-ha-REE-ya), more than 200 miles southwest of Cairo, a local man who guarded the tumbledown 2,300-year-old temple of Alexander the Great was headed to work on his donkey.

As the guard and his mount crossed the desert beneath a withering sun, the improbable happened. Half a mile from the temple the donkey's hoof literally fell *through* the sand.

"The guard got off his donkey," Zahi Hawass tells me. "He helped the animal up and looked into the hole that had been created. Inside he saw a tomb."

Hawass, director general of the Giza Pyramids, Saqqara, and the Bahariya Oasis, is a sturdy, energetic man with piercing eyes and a leonine grin. "By law," he continues, "the area had to be isolated and assessed by archaeologists. And this is what we have. . . ." Hawass lifts his red-shirted arm and motions across the desert, where at least 150 rectangular indentations the size of school buses dimple the sand. "We're finding that each of these depressions is a tomb," he says. "There have been Greco-Roman mummies in every one we excavate. Mummies everywhere! In fact, we've decided



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to call this place the Valley of the Mummies."

In the desert around us workers use mattocks and bushel baskets to remove sand from three tombs, part of a cemetery built during Egypt's Greco-Roman period, when the Greeks and later the Romans controlled Egypt from 332 B.C. until the fourth century A.D. It was roughly 2,800 years after the peoples along the Nile in Upper and Lower Egypt were unified. In the centuries that followed, Egypt became one of the most advanced civilizations on Earth, developing the technologies needed to build pyramids for their leaders' eternal life.

Short flights of stairs descend into two of the tombs. In each a central hallway leads to burial rooms where individual mummies or mummified families have been interred with their worldly goods for use in the afterlife.

The third tomb is a square pit about 15 feet deep; around the sides burial niches burrow into the walls. In one of those niches workers found a mummy that Hawass has nicknamed Mr. X. The mummy, wrapped tightly in resin-soaked gauze as brown as dry tobacco, is an odd mixture of human form and austere sculptural lines. The longer I look at him, the more I can't get past the idea that he lived before Muhammad, and maybe even before Jesus, walked the Earth. Yet there he is—a silent messenger from another world.

A flurry of activity draws Hawass to a nearby tomb, where diggers have just uncovered a family of six gilded mummies, including two infants. Hawass hurries down into the crypt and, with a tiny brush, carefully cleans the sand from one of the adults, revealing a face with mother-of-pearl eyes.

"We estimate that only 30 percent of what the ancient Egyptians left behind has been discovered," Hawass says later. "So when I come to a place like this, I'm always excited. I love digging into the unknown, and we've only begun our work here. I'm sure we'll learn a lot more about Egypt during the Greek and Roman periods, a time in our history not completely understood."

Alexander the Great launched Egypt's Greco-Roman period in 332 B.C. After conquering parts of western Asia, the Macedonian general was welcomed in Egypt by a people politically weary after several hundred years of unrest and occupation by outsiders.

The mixing of Greek (and later Roman) influences with a still rich Egyptian culture helped set social and religious change spinning around the Mediterranean. In this newest period of vibrancy the Egyptians' styles of dress and sculpture worked their way to Greece and Rome, while Egyptian gods and demigods mingled with their counterparts in Greek and Roman mythology. The mother goddess Isis would eventually have temples built to her in the land of the Caesars, while

CARVED into stone beneath the sands of Bahariya Oasis, a multi-chambered tomb (left) may have been used by a single family for two centuries. The entire ancient graveyard may underlie as much as 14 square miles on the edge of the oasis. Its burials span perhaps 600 years—from Alexander the Great's conquest in 332 B.C. until the fourth century A.D., when Rome ruled Egypt.

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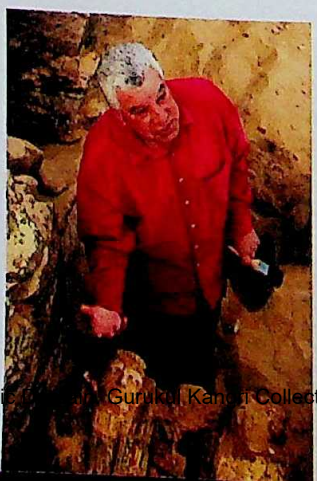
ETERNAL VARIETY

AN UNADORNED MUMMY (above) named Mr. X by Zahi Hawass, director general of the Giza monuments (below), may be one of the cemetery's earliest occupants. A clay coffin (right) dates from the Roman period. By A.D. 350 Christianity flourished in the Mediterranean world, and the practice of mummification began to disappear.

many Greco-Roman gods and heroes would be honored in temples throughout Egypt. Here at Bahariya temples honored both Alexander the Great and the Greek demigod Heracles.

For several centuries after Alexander, Egypt thrived. During this period of political stability its international trade flourished, its rulers imported more efficient ways to cultivate food, and its population boomed. No longer preoccupied with defense, its people could spend more time enjoying life's beauties and preparing for the hereafter. In the days of the pharaohs only royalty and the ruling elite could afford funerary face masks; now the upper class and possibly the middle class commissioned them as well. Artisans also fashioned cartonnages: rectangular chest plates in gilded plaster and linen that reflected the deceased's place in society.



But as ancient Egypt flowered again, the reasons behind some of its time-honored practices were forgotten, discarded, or altered. "By the Greco-Roman period," says Nasry Iskander, general director of conservation at the Egyptian Museum in Cairo, "in the ways of mummification most Egyptians were merely going through the motions. They were carrying on this tradition, but maybe they could no longer remember why."

To prepare the deceased for the afterlife during pharaonic times, funerary workers removed most internal organs, then sterilized the body and dried it by packing it—inside and out—with natron salts. About 40 days later the body was wrapped in linen strips, placed in a series of wooden cases and an outer stone coffin, and laid in a crypt. The body faced east to greet the rising sun in symbolic rebirth.

"But look here," Iskander says, pointing at the crypt. "Very few of the mummies so far discovered here are even buried in coffins, and their tombs are not all oriented facing east in the traditional style. And sometimes two, three, or more mummies have been piled in a tomb intended for one."

Other aspects of the burials differ as well. None of the 105 mummies excavated so far at Bahariya were buried with canopic jars, common in tombs

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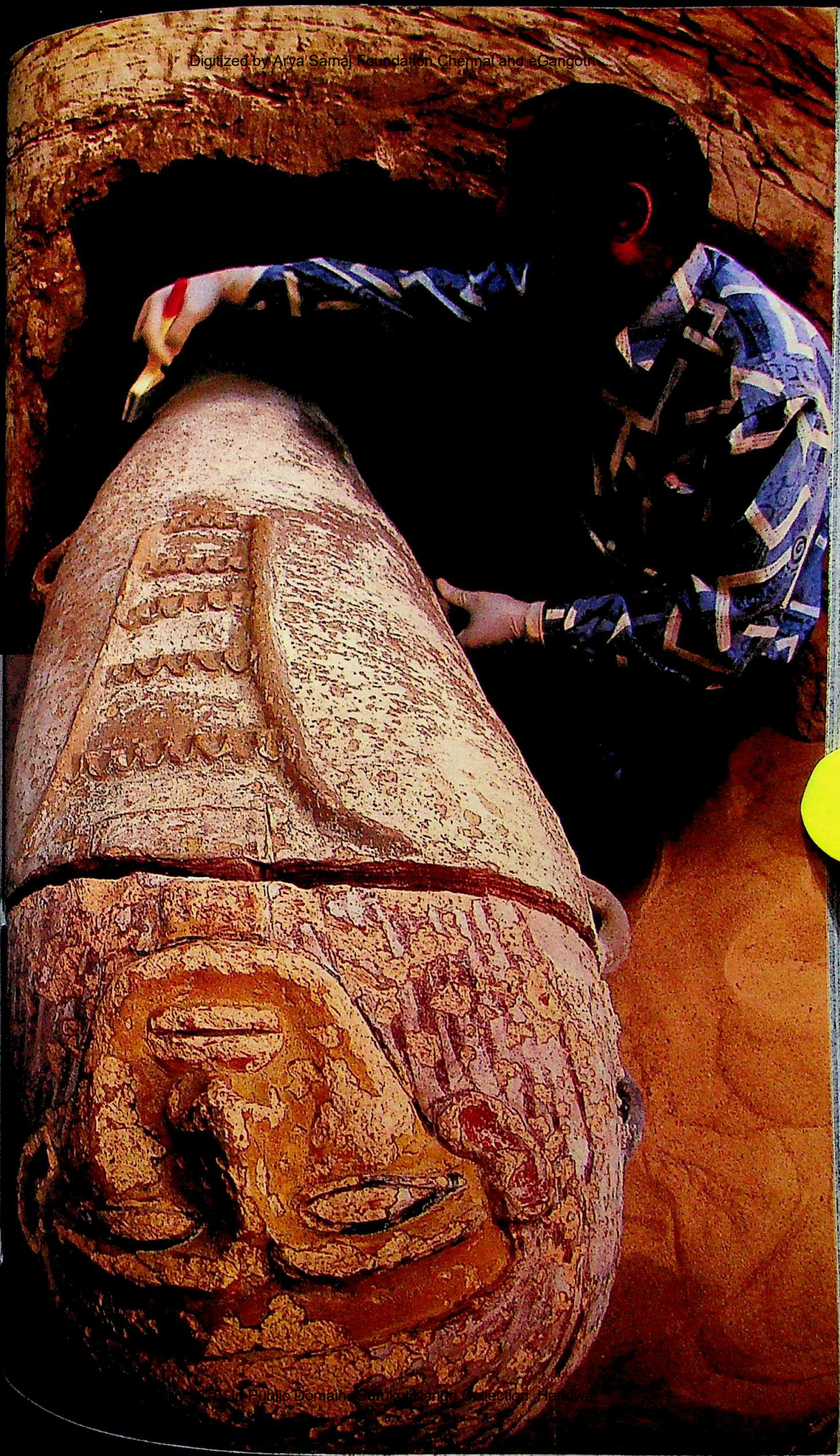

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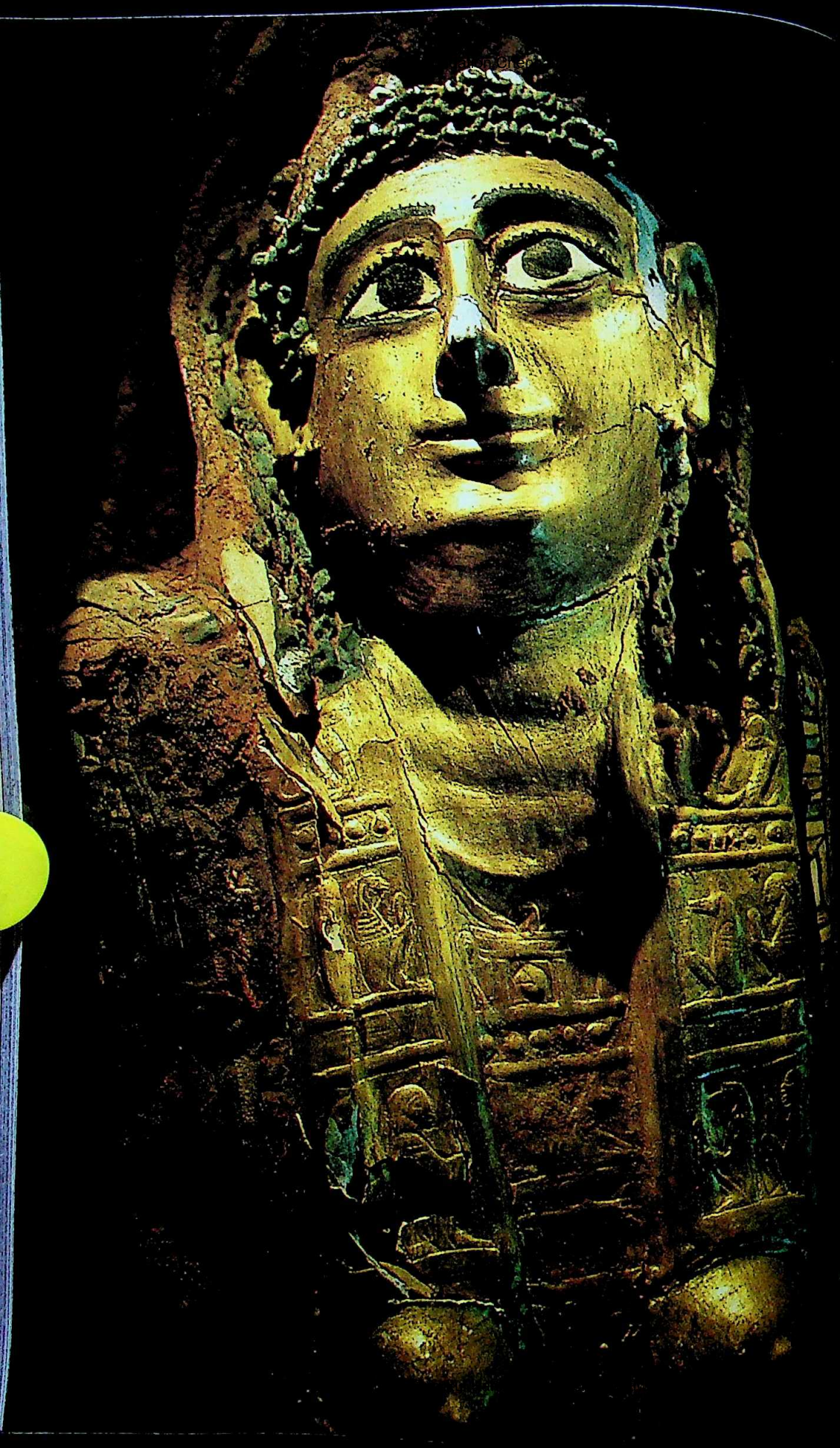

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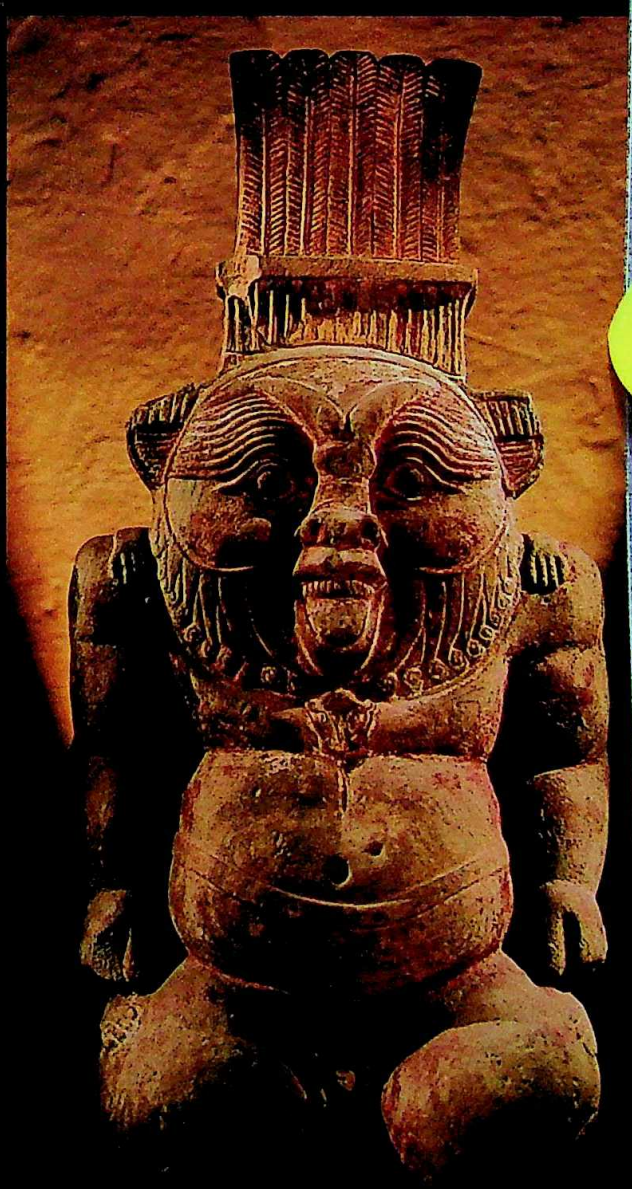

ITS GAZE FIXED on the next world, the golden covering of a female mummy (left) was probably selected from a local workshop. The roster of deities thought to control daily events and eternal fate grew longer through the Greco-Roman period. Part dwarf, part lion, the Egyptian god Bes (right) guarded pregnant women and newborns. Among the ruins of a temple named for Alexander the Great, excavators found statues of a goddess figure blending Egyptian Isis and Greek Aphrodite (above, at left) and Osiris, Egypt's lord of the underworld, at right. A clay mother and child (above right) hints at later Christian themes.

from pharaonic times. The jars, which held the deceased's lungs, stomach, intestines, and liver, were decorated with paintings or reliefs of the four sons of Horus, the powerful sky god. By Greco-Roman times the jars had been replaced by symbolic drawings of the four sons on the cartonnage.

Iskander believes that these changes indicate a loosening of traditional religious practices, which may have been diluted by the new beliefs imported by the Greeks and Romans. The changes may also be a sign of increased pressure on embalmers, who—with the upper classes clamoring for their services—had more bodies to prepare for the afterlife.

In the tomb at our feet two archaeologists brush the final layers of sand from Mr. X. Then, before getting face-to-face with the mummy, they stop to pull on surgeon's masks.

"It's always preferable to wear masks when you excavate freshly opened tombs," Iskander says. "Masks keep out ancient dormant viruses or bacteria that might exist with the mummy. If you breathe the viruses or bacteria in, the heat and moisture from your lungs can revive them. If your immune system isn't prepared, you can die. Fast. In days or a week. It has happened a few times. And while not the fabled mummy's curse, it's real enough."

The uncovering of Mr. X brings Hawass

DONOVAN WEBSTER, a frequent contributor, lives outside Charlottesville, Virginia. KENNETH GARRETT, also a Virginia resident, has photographed archaeological digs from Chile to China.

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ELABORATE MUMMIES proclaim a family's status (left). Decorated breastplates show these people could afford a gilded afterlife. But painted details (above) mystify experts. Who are the Egyptian figures crowned by solar disks? Is the running image, below, the Greek god Hermes, escort to the underworld? Years of excavation ahead may provide the answers.

over from another part of the excavation. As he looks into Mr. X's tomb, Hawass bows his head and removes his hat, holding it by its felt brim. After a moment of quiet he says that each time he disturbs a grave, the scientist inside him wars with the human being. Because of these conflicting feelings he usually favors excavating as few tombs as possible at any site. "In one way," he says, "I find this so exciting. Who can predict what Mr. X will tell us of his world? But I also dislike disturbing mummies, as they have started the long journey into the afterlife, and we are intruding. So I ask Mr. X's forgiveness, that he may teach us something of his world. Then I will return him and his goods to this place so he can go on to paradise."

As the excavation continues, Hawass, Iskander, a dozen experts, and 70 laborers gather more information about the Valley of the Mummies and Egypt's Greco-Roman period. The graveyard may stretch much farther than originally thought—perhaps three or four miles on a side. Ancient Bahariya may have been home to 30,000 farmers, winemakers, and artisans. And the cemetery is more densely packed with tombs than the scientists first believed. One afternoon when team members back a four-wheel drive next to the site's guardhouse, the rear wheel plunges through the ground, revealing yet another tomb. Past surveys of the surrounding desert have unearthed a temple dedicated to Bes, the Egyptian god of pregnancy and newborns, as well as the ancient courtyard, towers, and

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ramparts of a military garrison for Greek and Roman soldiers.

The scientists have also discovered that Bahariya Oasis is drying up. During the Greco-Roman period the water table lay only 15 feet beneath the surface; today, wells must be sunk 4,500 feet to hit water.

Throughout the oasis workers have unearthed more than 7,000 artifacts. One afternoon Hawass shows me the provisional museum at the *taftish*, the antiquities headquarters in nearby Bawiti where many of them are stored. Inside a series of secure buildings near the center of town, curators welcome Hawass like royalty. We walk to a locked room where three mummies rest in glass cases monitored for temperature and humidity.

"We found these mummies last year," he says, "but we realized we'd need a very thorough excavation, so we closed the tomb until now. These came from one of the excavations we worked on today."

One of the mummies wears a headdress with a gilded scene of a flying falcon—probably the god Horus, an ancient symbol of royalty. All three have gilded cartonnages that are brightly painted.

"You can tell by the gold, the flying Horus, and the cartonnages that these people were rich," Hawass says. "They were probably from a higher class. They might have been overseers of the desert, managing the farmers who cultivated crops. We have found evidence that Bahariya was a large government wine-making center."

The mummies' funerary masks, with their curls, long aquiline noses, and wide eyes, reflect the influence of Greek sculpture. And instead of the solid gold of pharaonic masks, each of these masks is made of plaster coated with a thin layer of gold.

The reason for the change? Before the arrival of the Greeks, Hawass says, Egyptians bartered for goods and services instead of using money. Then the Greeks introduced coinage, which eventually led to a wider distribution of wealth. More people could afford to buy burial masks, so workshops began producing more of the gilded variety—masks that had the look of royal versions but not the price.

Other glass cases hold a dozen unusual foot-high statues of wailing mourners found with one gilded mummy. Hawass believes you can tell how important people were by the number

CONQUERORS' COINS could be useful in a netherworld infiltrated by their gods. Most of these bronze pieces from a Bahariya tomb are from the Roman period. Guarding trade routes linking the western oases, a Roman fort (right) embodies the centuries of foreign rule that recast Egyptian life—and afterlife.

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"WE'VE ONLY BEGUN OUR WORK HERE. I'M SURE WE'LL LEARN A LOT MORE ABOUT EGYPT DURING THE GREEK AND ROMAN PERIODS."

of symbolic mourners buried with them.

We step through another door to a brightly lit laboratory where some of Bahariya's antiquities are repaired or cleaned, revealing the history beneath two millennia of sand and dirt. Hawass picks up a four-inch-high faience falcon, fired to a rich greenish blue. The bird is perfect. Its individual feathers are visible and detailed. Its wings fold to a graceful V behind its back; its hooked beak looks ready to rip open the next unlucky prey locked in its talons.

Emanating both elegance and antiquity, the falcon is one of the most beautiful objects I've ever seen, and I can't help but wonder who was the last person in ancient times to hold it. Who, like me, regarded it as so perfect that he wouldn't want to depart for the afterlife without it? Did he die with it in his hands?

Before I can ask these questions, Hawass puts the sculpture back on the table and lifts an eight-inch square of limestone etched with concentric circles. "Look at this," he says, handing me the slab, heavy as a brick. "It's an early board game found in the tomb with the gilded mummies. Can't you imagine the ancient Egyptians playing this very game?"

The bull's-eye has been scooped out, and a small cube of etched limestone—a die—teeters in it. I hold the game gently, careful not to tilt it and roll the die. Who made this? And how many days and nights did they spend huddled over it, immersed in contests full of teasing, bickering, and maybe even wagering?

"There were not the social diversions here that existed in the cities," Hawass explains, taking the slab from my hands and returning it to the table. "So they played games, had parties. Can't you see them eating dates and olives, drinking wine? This is why I love my job so much," Hawass says, pausing to ignite one last smile. "Each time we find an artifact like this, it helps bring a whole world back alive." □

Excavating burial sites: Are we trespassing on sacred ground? Comment online at *www.nationalgeographic.com/ngm/9910.*

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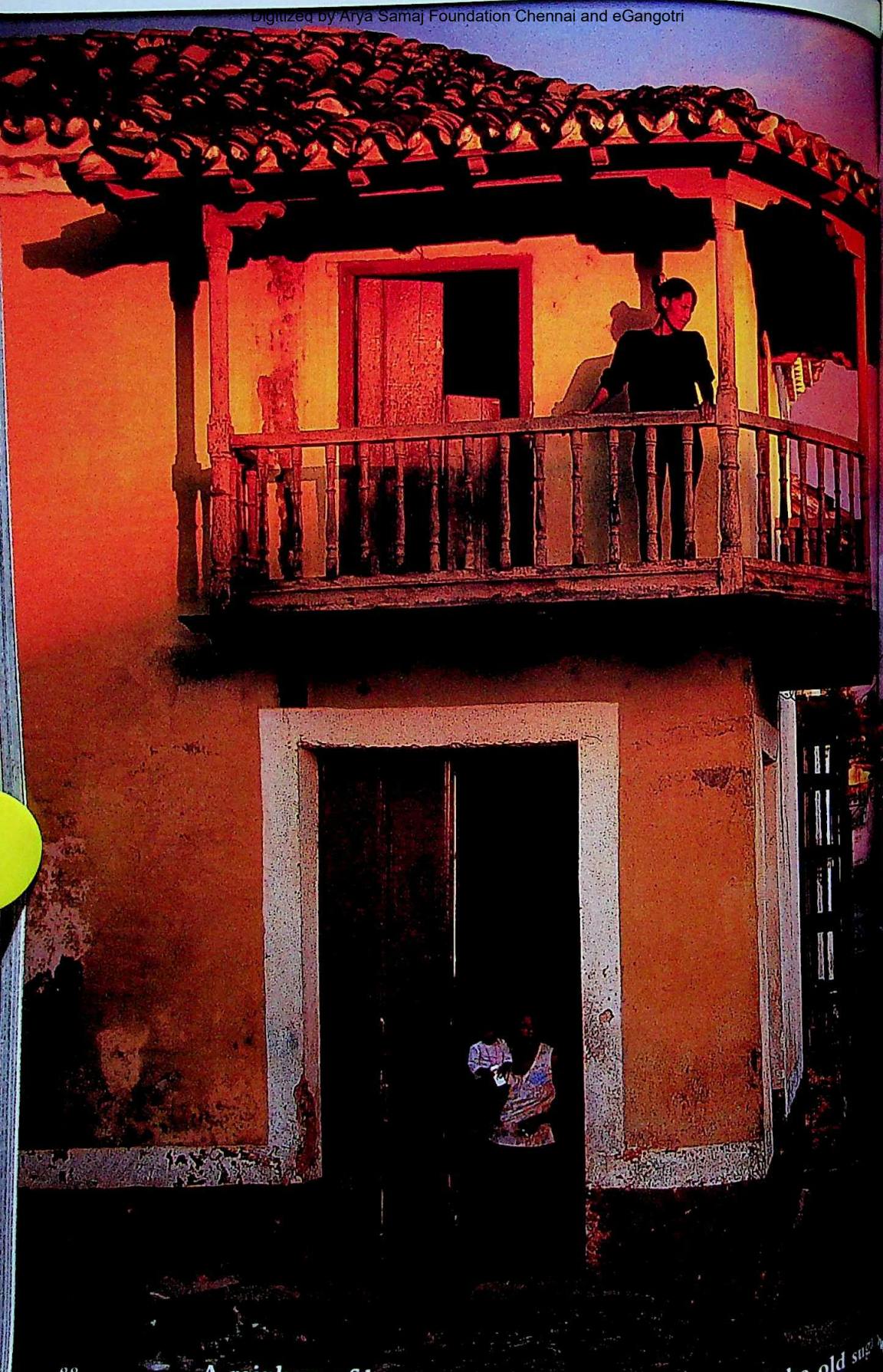

A rainbow of homes from its golden age helped the old sug[illegible]n of Tr[illegible]

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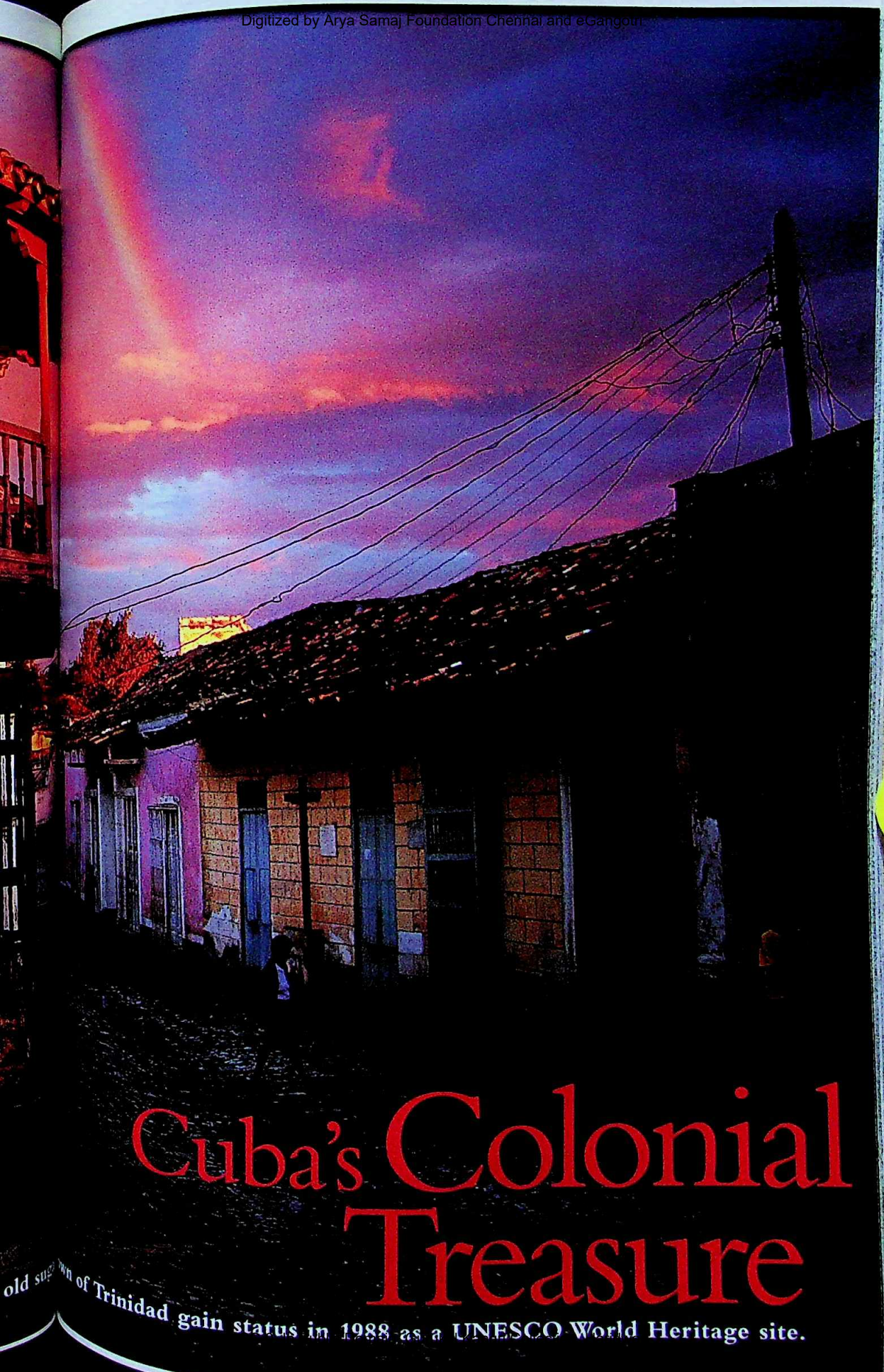

Cuba's Colonial Treasure

old sug[illegible]n of Trinidad gain status in 1988 as a UNESCO World Heritage site.

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Friends and family visit streetside in this living monument, which has embraced generations of Trinitarios for almost 500 years. "There's no other place like it in all of Cuba," says an elderly resident. "My wife and I were born here, and we love it."

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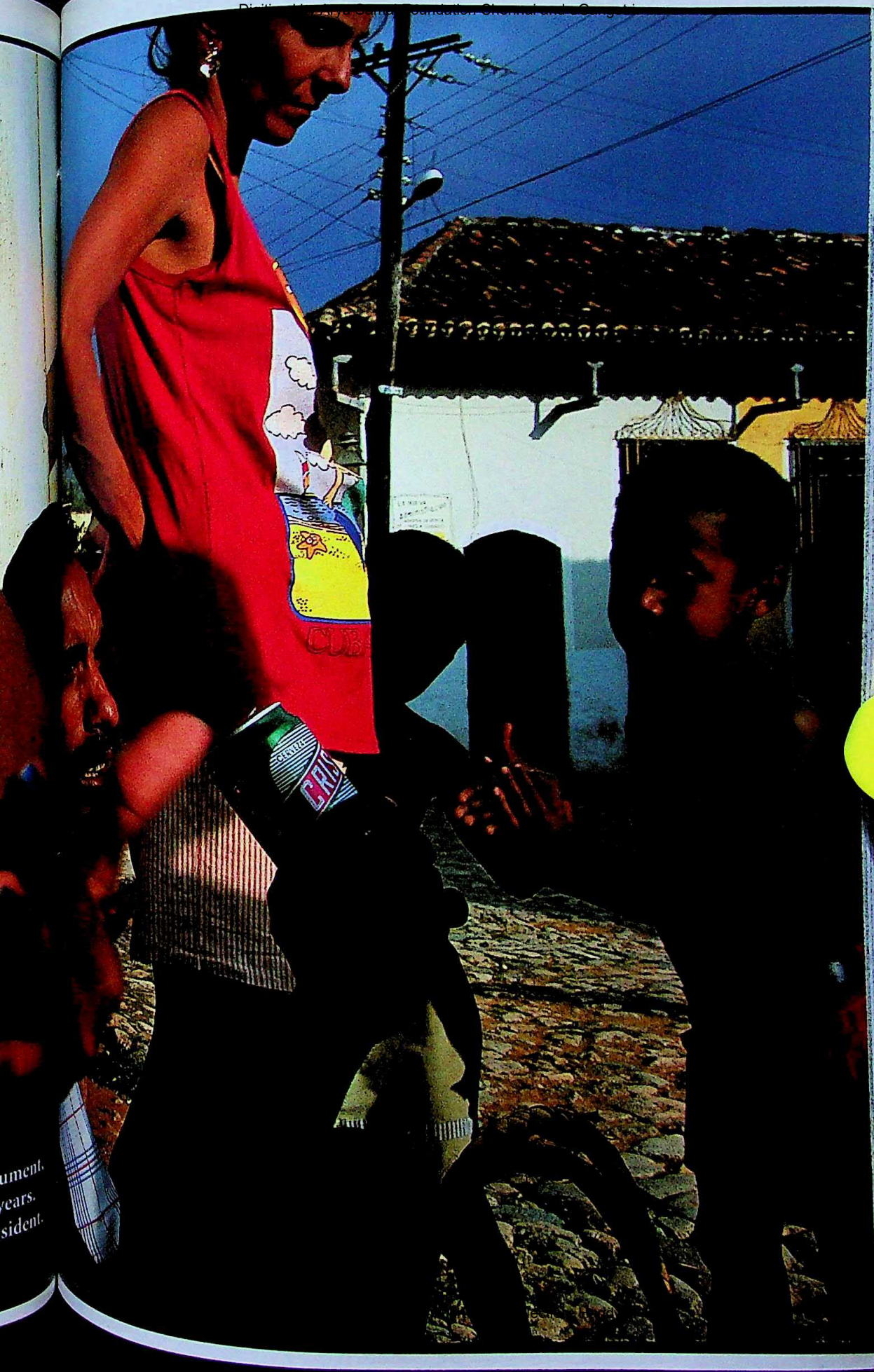

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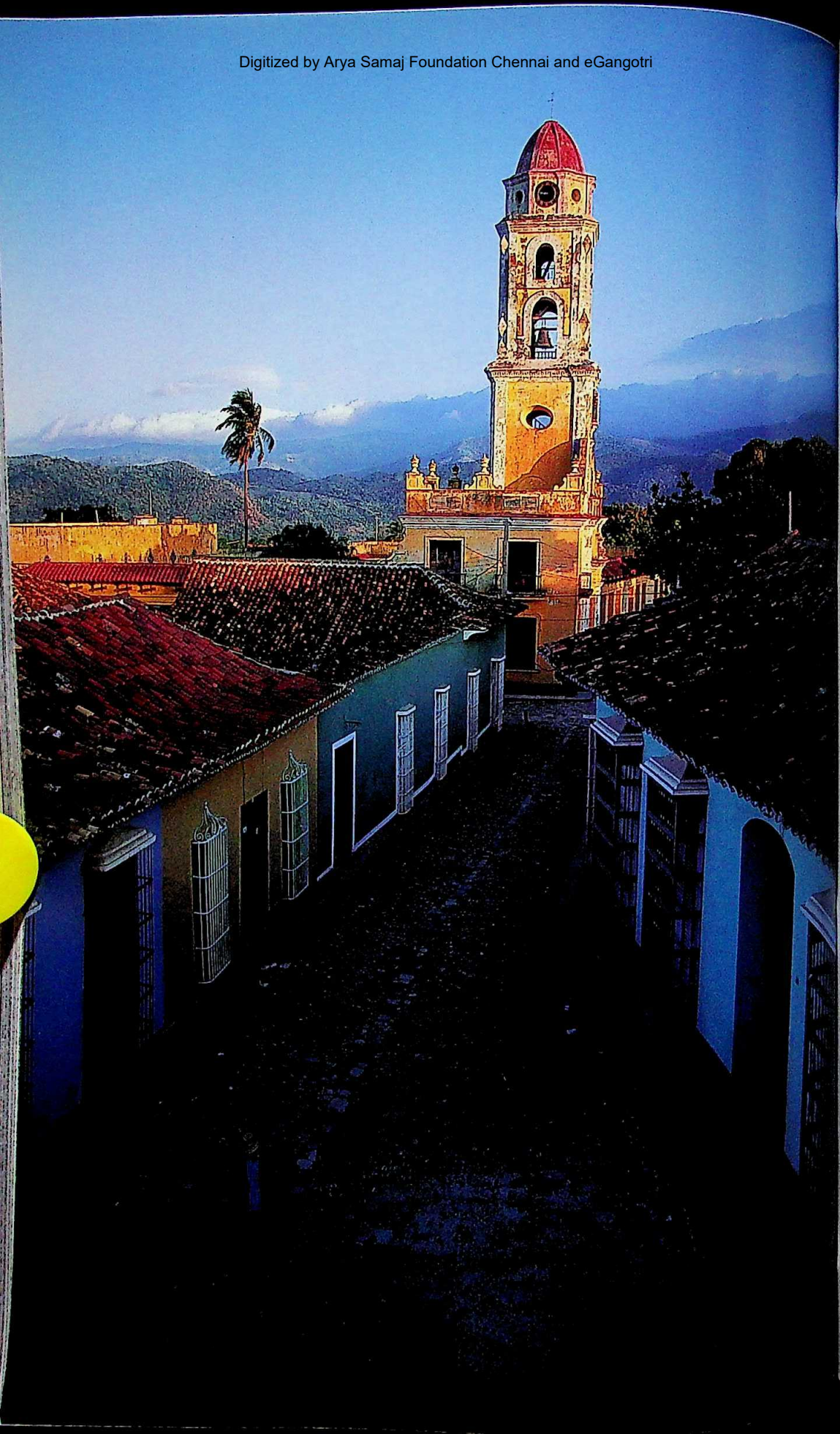

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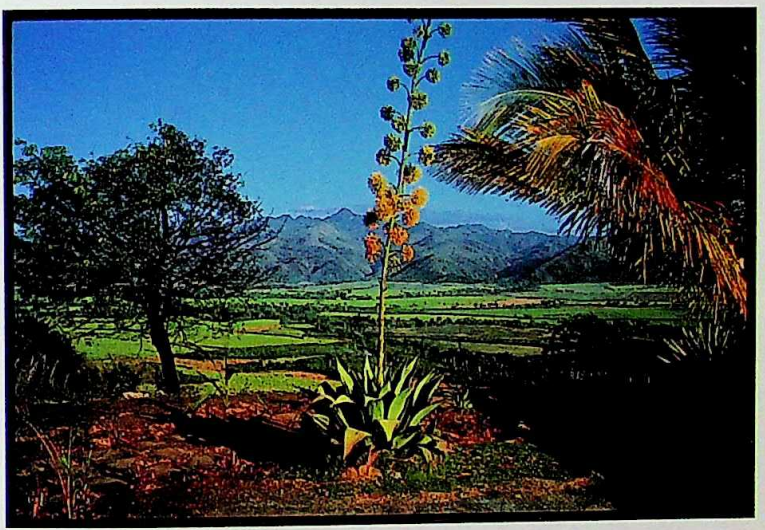
By A. R. WILLIAMS • *Photographs by* DAVID ALAN HARVEY
BOTH NATIONAL GEOGRAPHIC STAFF

Tucked between the Sierra del Escambray and the Caribbean Sea, the site of Trinidad was originally home to the native Taino, who panned for gold in nearby rivers. Conquistadores founded the Villa de la Santísima Trinidad, Spain's third settlement in Cuba, in 1514. Amid streets laid out around a spacious plaza, Hernán Cortés organized men and supplies



for his conquest of Mexico. With the wealth of the Aztec eclipsing anything found here, Trinidad became an outpost of smugglers and pirates. The Taino were virtually exterminated by 1550.

Boom times came in the late 18th century, when profits from sugar—grown in the Valley of the Sugar Mills (above)—bankrolled the construction of fine houses and buildings such as the former Convent of San Francisco, whose tower is the town's most recognized landmark (left). In 1689 the town had 980 residents; by 1755 it had almost 6,000. As the plantation era faded, Trinidad turned into a backwater once again. The railroad didn't reach here until 1919 and a highway not until the 1950s. Isolation preserved the colonial heart of the town, where 6,000 people live today. Protected by law, the old neighborhoods are being restored.

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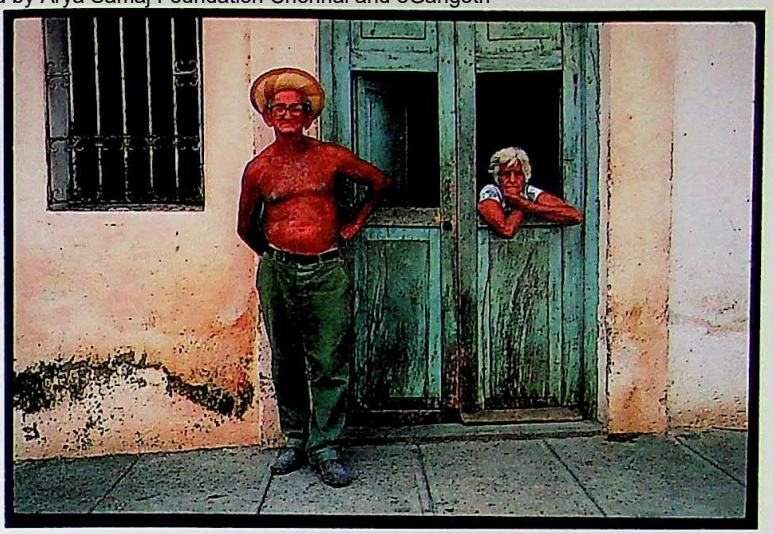
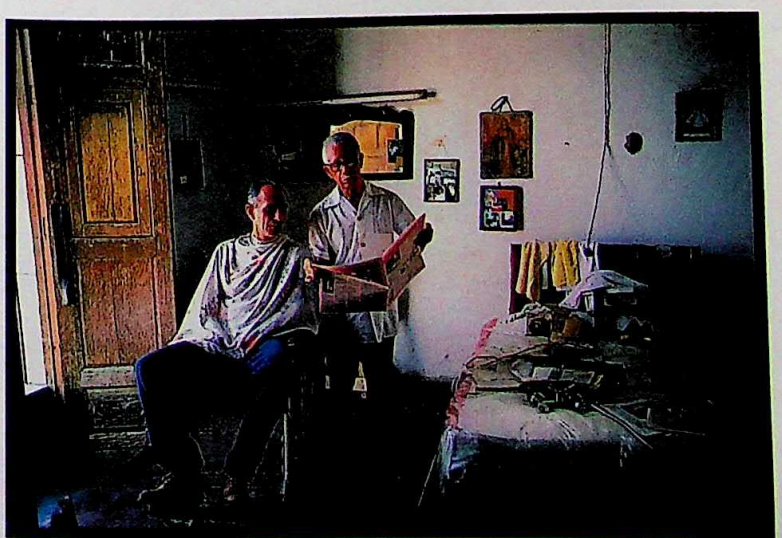


Along streets resonant with the clip-clop of horses' hoofs and the squeak of bicycles, life moves at a pace from decades past. A young man tinkers with a U.S. jalopy by the curb. An older couple watch the passing parade from their front door. Sharing news with a customer, Orestes Ramírez Soa scans an issue of *Granma*, the official state paper, which he bought from a vendor at his open window. Ramírez Soa gives an old-fashioned shave—hot lather, applied with a brush, and quick deft strokes with a straight razor. The experience was so soothing for photographer David Harvey that he fell asleep on one of his regular visits. Ramírez Soa's equipment is wearing out though. Giving Harvey a sketch of barber's shears, he asked, "Do you think you could bring me a pair like this when you come back?"



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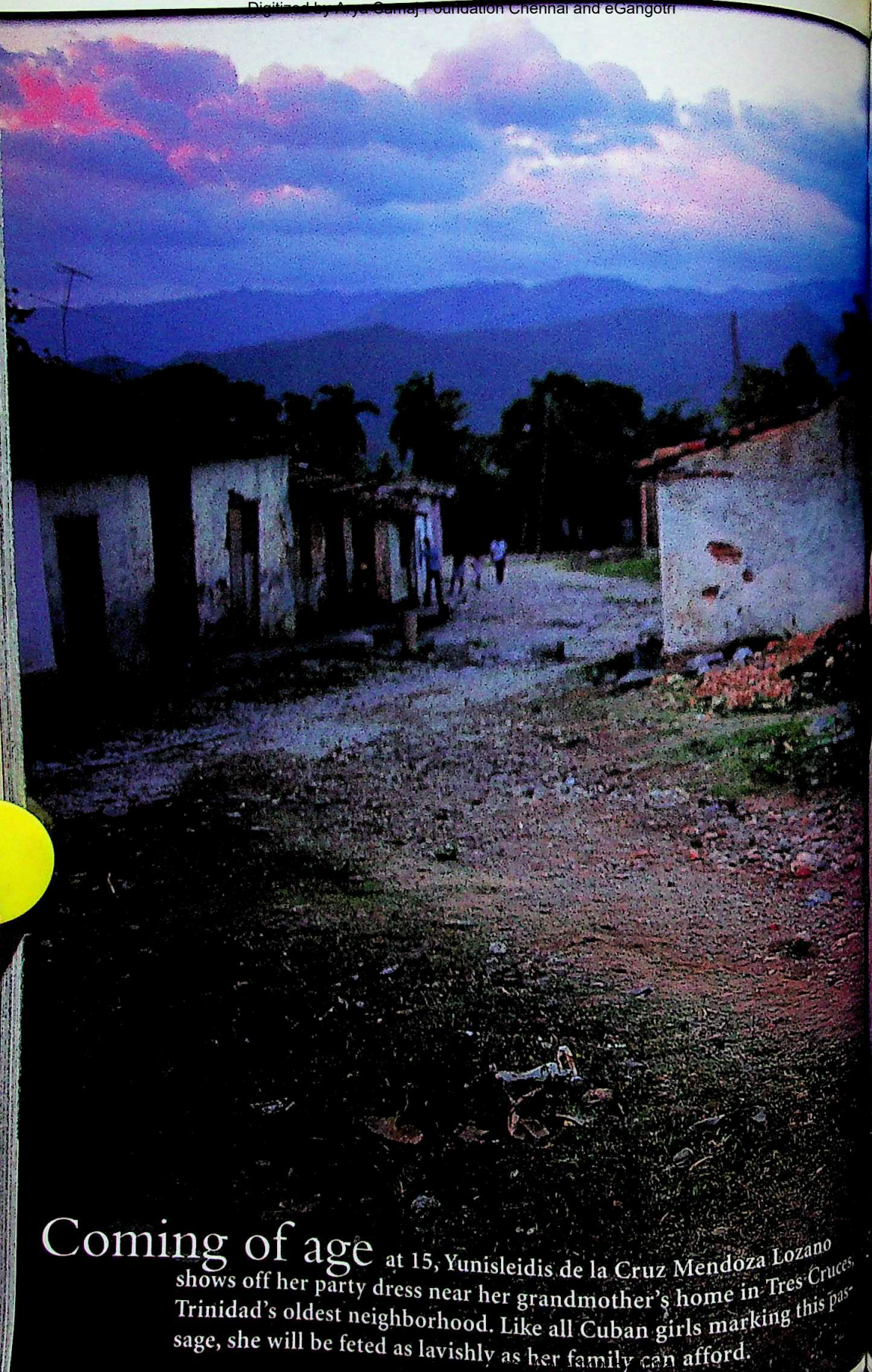

Coming of age at 15, Yunisleidis de la Cruz Mendoza Lozano shows off her party dress near her grandmother's home in Tres Cruces, Trinidad's oldest neighborhood. Like all Cuban girls marking this passage, she will be feted as lavishly as her family can afford.

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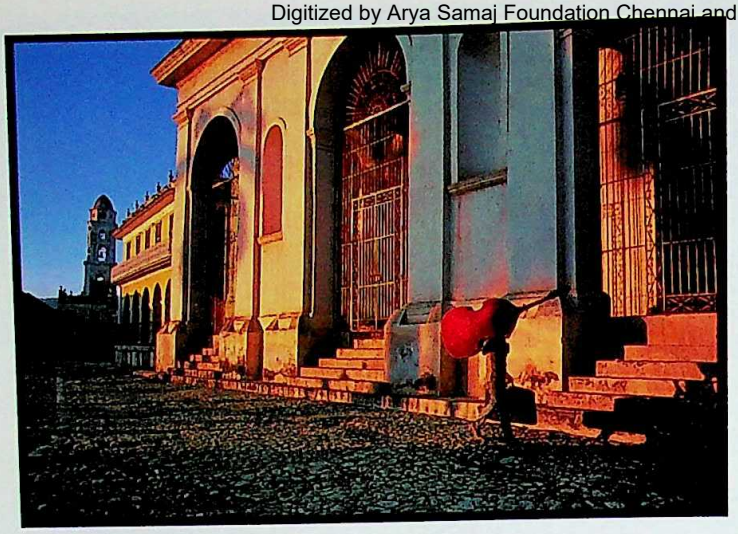
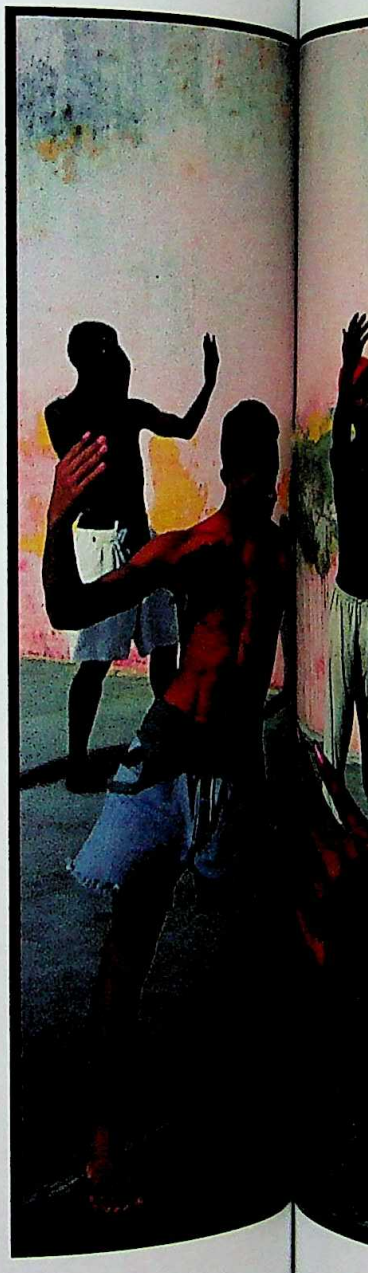
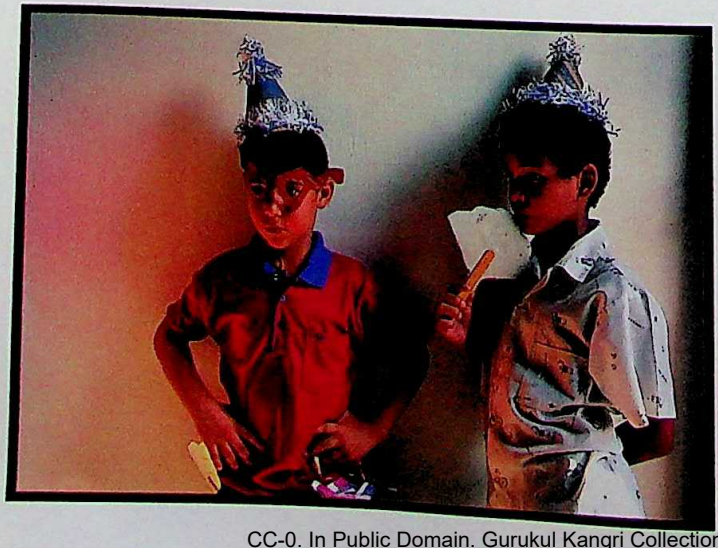




Music fills every corner of this culturally rich town. In an empty courtyard on weekday mornings the Trinidad Folkloric Ballet moves to Afro-Cuban rhythms, preparing their repertoire for audiences at home and abroad. "Some of our dance traditions are similar to those in other parts of Cuba, but others are specific to here," says Gisela Zerquera Calderón, the group's director. "We think it's important to keep them alive and show them to the world."

Visitors from around the world come mostly as day-trippers in tour buses. Around the main plaza, where a musician passes the parish church (above), they invariably find street bands playing Cuban songs on conga drums, clay pipes, a guitar, and bass. Music and dancing are even part of a child's birthday party—after cake and candles, a clown, and games.



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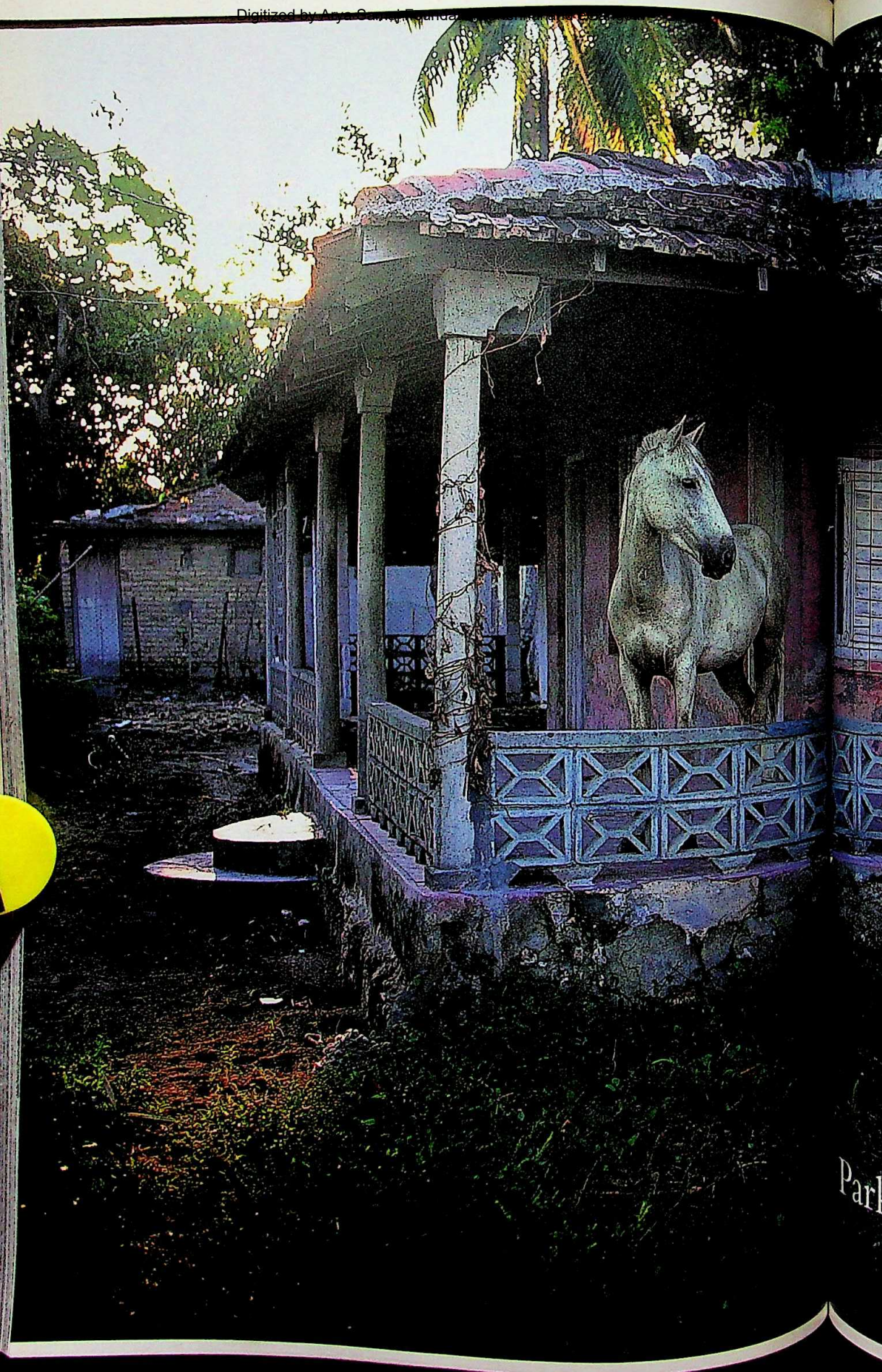

Parked overnight on a porch, a horse will soon be put to work. With public and private vehicles scarce in Cuba, Trinitarios continue to rely on horses and burros to carry children to school, take vendors on their rounds, and even pull the trash-collection cart.

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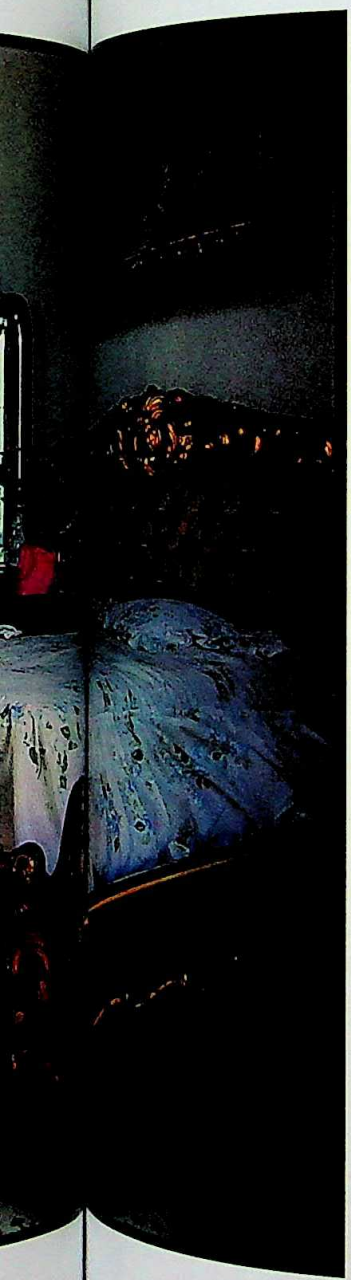

A glimmer of elegance from the time when Trinidad was a cosmopolitan center of culture and trade lives on behind a few of the shuttered windows along cobbled streets (above). Elsa Zayas Mendoza (below) shares one of the grand 18th-century houses with her husband, a retired lawyer. Rosa Orbea Cerrillo (left, at left) and her husband run a bed-and-breakfast in another. In their best room she prepares her niece Annalien for her 15th-birthday photographs. "I love that girl as if she were my own daughter," she says. "I'm very protective of her." With eyes fixed on the future, Annalien dreams of studying acting in Havana. Her aunt tells her the dream will keep until she finishes school in three years. "This is a small, provincial town, and she has never been anywhere else. She's just not ready to take on the big city yet."

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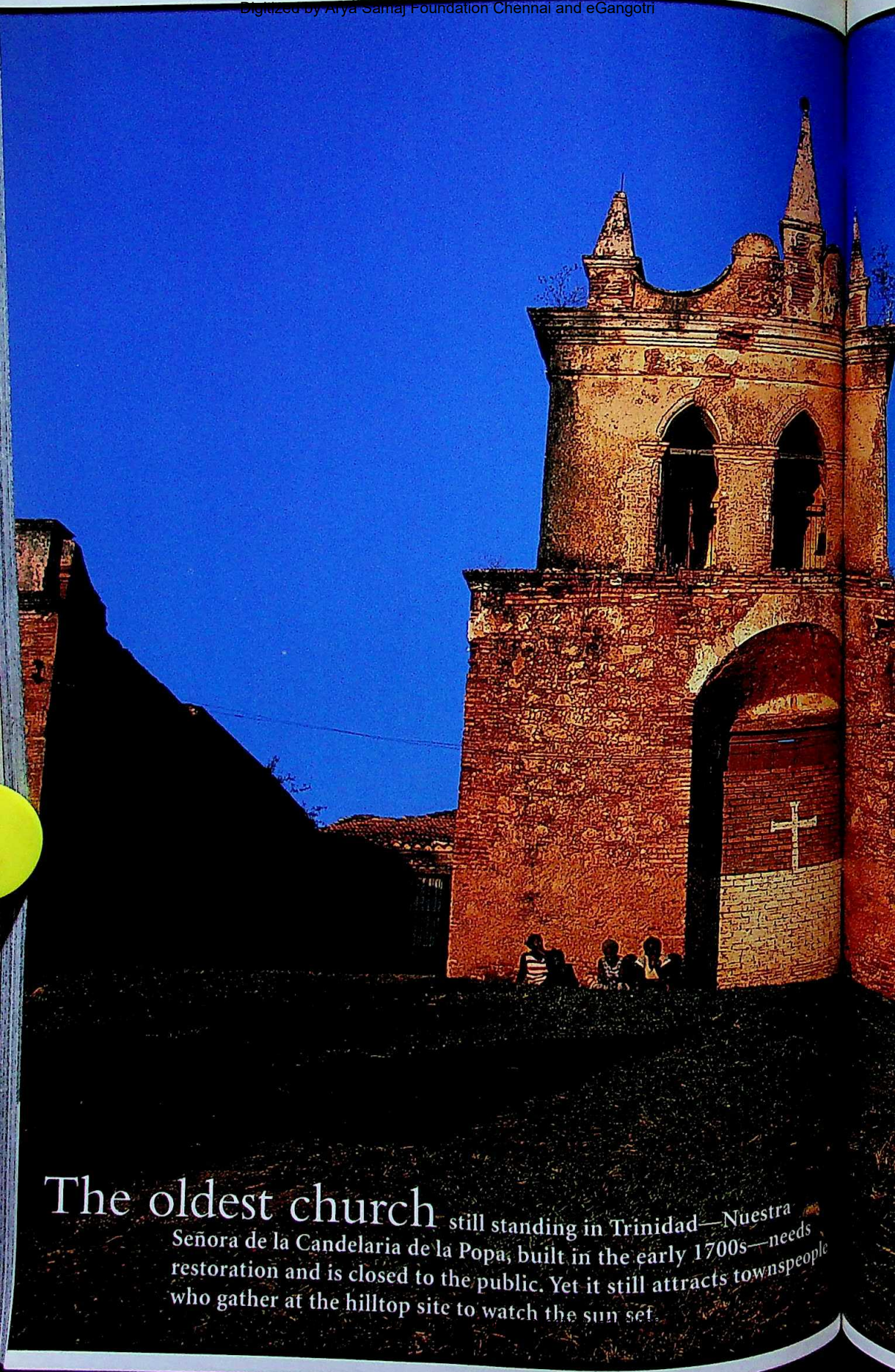

The oldest church still standing in Trinidad—Nuestra Señora de la Candelaria de la Popa, built in the early 1700s—needs restoration and is closed to the public. Yet it still attracts townspeople who gather at the hilltop site to watch the sun set.

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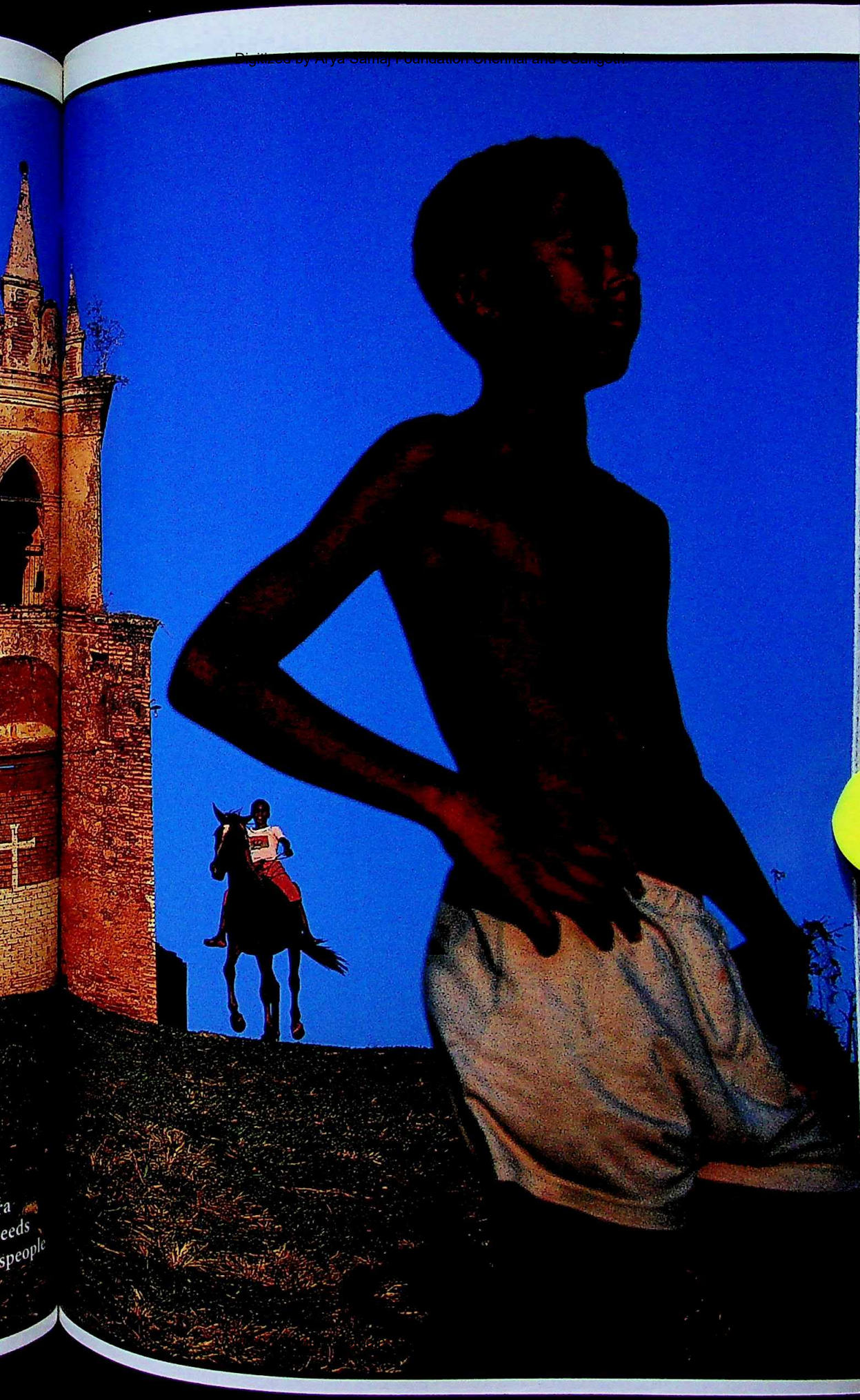

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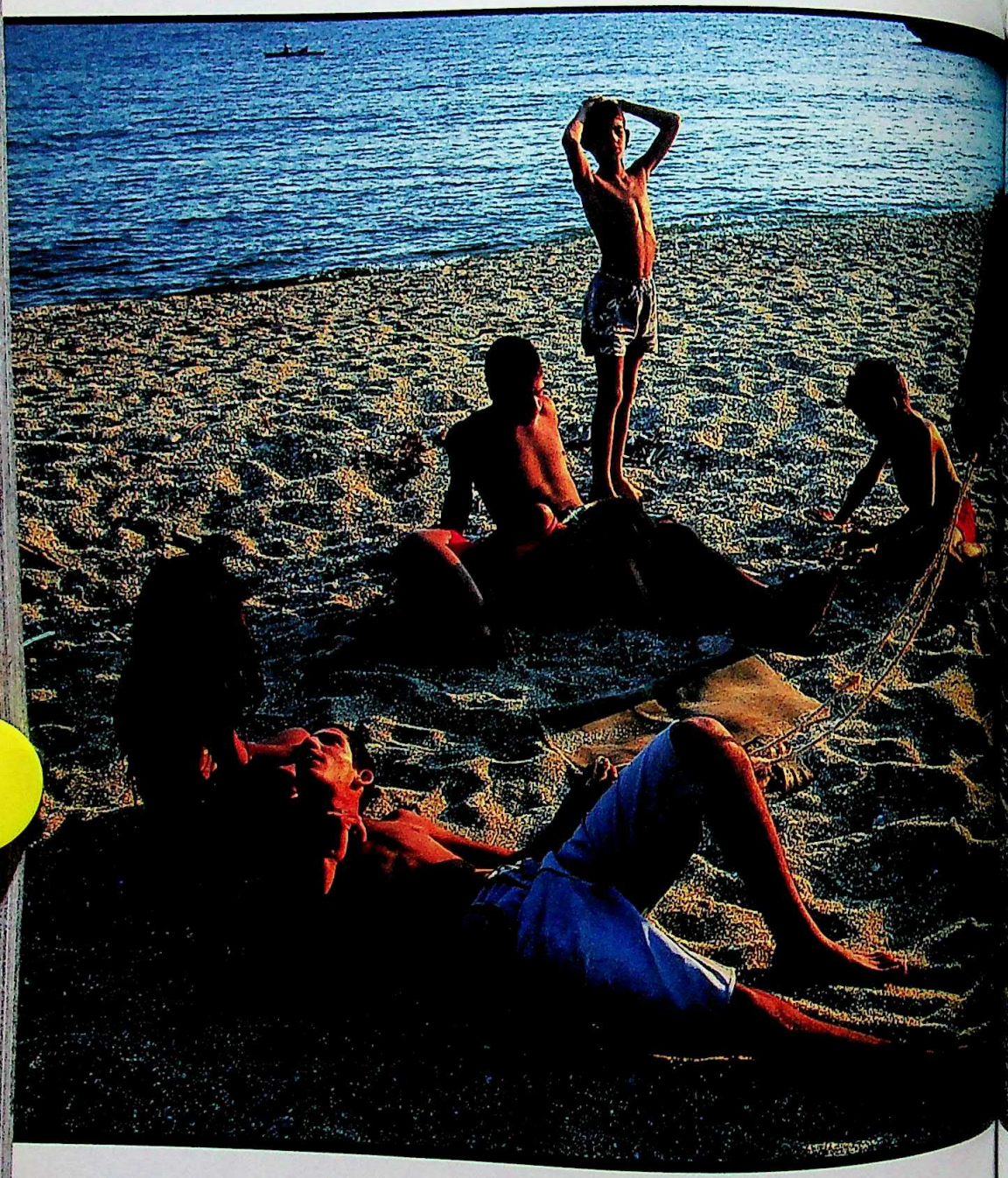

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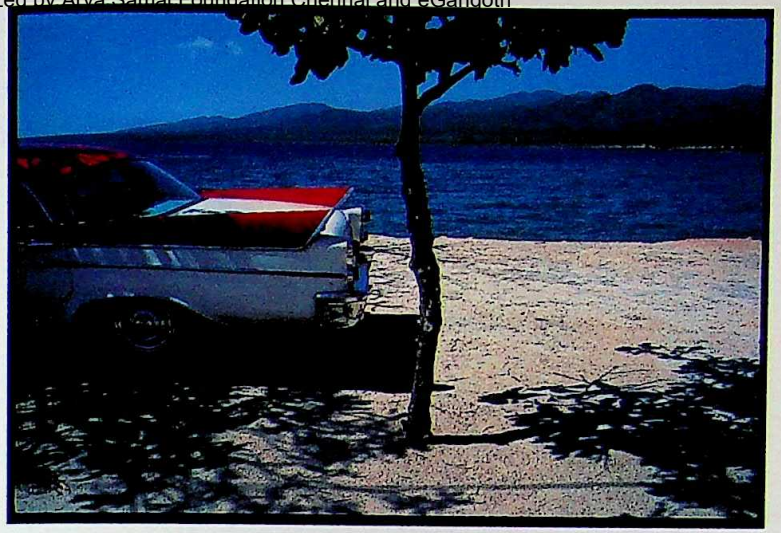
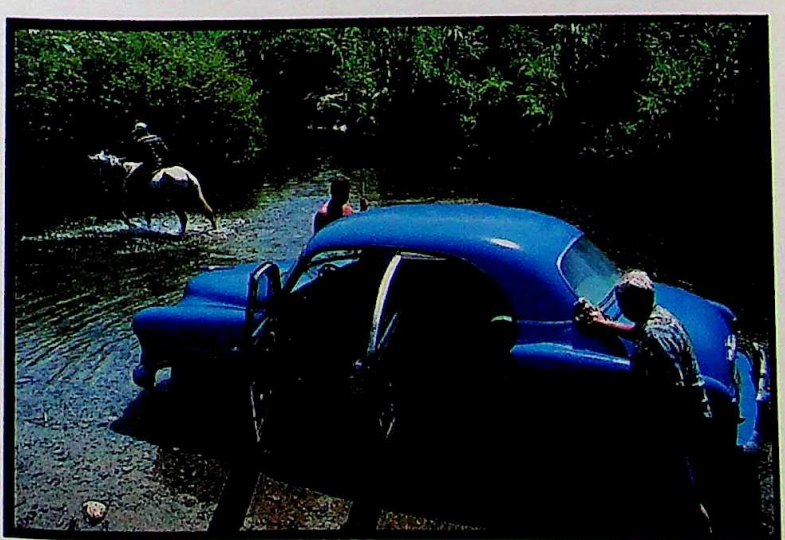


The sea opened Trinidad to the world, bringing in conquistadores, sugar traders, and visitors such as 19th-century naturalist Alexander von Humboldt. Today its unspoiled Caribbean shore draws a growing number of tourists, who come mostly from Europe, Canada, and the rest of Latin America. For locals, getting to the beach is as easy as a slow cruise via classic car or four-legged transport. Mountain streams on their way to the sea have their own appeal.

Do Trinitarios realize how lucky they are to live here? "It's easy to forget how special this place is as we go about our daily lives, I guess," says a guard in one of the town's museums. "But all we have to do is look around to be reminded of its beauty." □

See more of David Alan Harvey's photographs of Cuba at *www.nationalgeographic.com/photography/harvey.*



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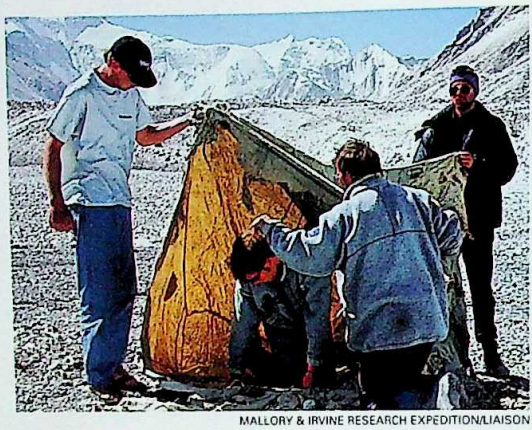
MYSTERY ON E

How I Found the Bod of Climb

BY CONRAD ANKER



MALLORY & IRVINE RESEARCH EXPEDITION/LIAISON

On June 8 experimen they vanis discovery

IT WAS A BRIGHT cold morning on Mount Everest. Sunlight coming over the Northeast Ridge made the rarefied air at 27,000 feet feel warmer than the 0°F it was. Seven thousand feet below in Tibet, pockets of meltwater shimmered on the terminus of the Rongpu Glacier, which bunched like a carpet as it pushed through the valley.

After an hour or so of searching I had found two bodies far apart on the lower edge of a snow terrace below and to the west of the standard route up the Northeast Ridge. Both were grotesquely twisted and folded, suggesting they had suffered long, violent falls. Their faded down suits indicated that they had perished during the past few decades. They weren't the climbers I was seeking.

Members of the Mallory & Irvine Research Expedition examine a tent (above) possibly dating from a 1933 British expedition that tried, in vain, to locate the legendary climbers' remains. The 1999 team found an oxygen bottle at about 28,000 feet, evidence of Mallory and Irvine's progress toward the summit.

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EVEREST

On June 6, 1924, George Leigh Mallory, at left, and Andrew Irvine set out with experimental oxygen bottles from Camp IV high on Mount Everest. Two days later they vanished into a bank of clouds. Were they the first to stand atop Everest? The discovery of Mallory's body answers some questions, but the riddle endures.

Climber George Mallory, Missing for 75 Years.

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MALLORY & IRVINE RESEARCH EXPEDITION/JIM FAGIOLO, LIAISON (OPPOSITE); AUDREY SALKELD COLLECTION

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I was on the mountain that day, May 1, 1999, as part of an expedition seeking clues to the fate of George Leigh Mallory and Andrew Irvine, the legendary British climbers who disappeared on the Northeast Ridge on June 8, 1924. Not far from there a British Expedition in 1933 discovered an ice ax with marks suggesting it had belonged to Irvine. Below where the ax was found, a Chinese climber, Wang Hongbao, in 1975 reported seeing a weathered body he described as an "English."

When I finished searching the terrace's lower edge, I took off my crampons to start back up a steep incline of loose rock and smooth slabs that had been exposed after a winter with little snowfall. A patch of white, different from the snow and as bright as marble, caught my eye. I realized it was a body. Bleached white skin. A hobnailed boot. A braided climbing rope. No nylon.

In my slowed-down, dreamlike state at high altitude, I did not immediately recognize who this was. I sat down next to the body, studying the tattered edges of his wool sweater and cotton wind jacket. He was facing uphill on his front, both arms outstretched, as if grasping to arrest his slide. His left leg was crossed over the right, which was broken above the ankle. I realized at last that I had found one of the two people for whom we'd been searching.

Because our radios could be monitored by dozens of climbers, our team had agreed to use coded messages. "The last time I tried a boulder problem in hobnailed boots I fell off,"

This is CONRAD ANKER's first writing assignment for the magazine, but he appeared on the cover of the February 1998 issue as a lonely figure on a precipice overlooking ice-choked mountains in Antarctica. He has climbed peaks around the world, notably in the Himalaya and Patagonia and on Canada's Baffin Island.

THOMAS H. POLLARD (BELOW); AUDREY SALKELD COLLECTION

EVER THE DASHING ENGLISHMEN, Mallory (above, at left) and Irvine joined forces to take advantage of Mallory's experience on Everest and Irvine's mastery of oxygen bottles. Their climb was Mallory's third time on the mountain in four years. "We've got to get up this time," Mallory wrote to his sister. The oxygen bottle and an ice ax found in 1933 place Mallory and Irvine close to the First Step, but still below the formidable Second Step, a 90-foot-high rock wall that leads to the summit (right). Author Conrad Anker (left), who found Mallory, climbed the Second Step on his way to the top last May.

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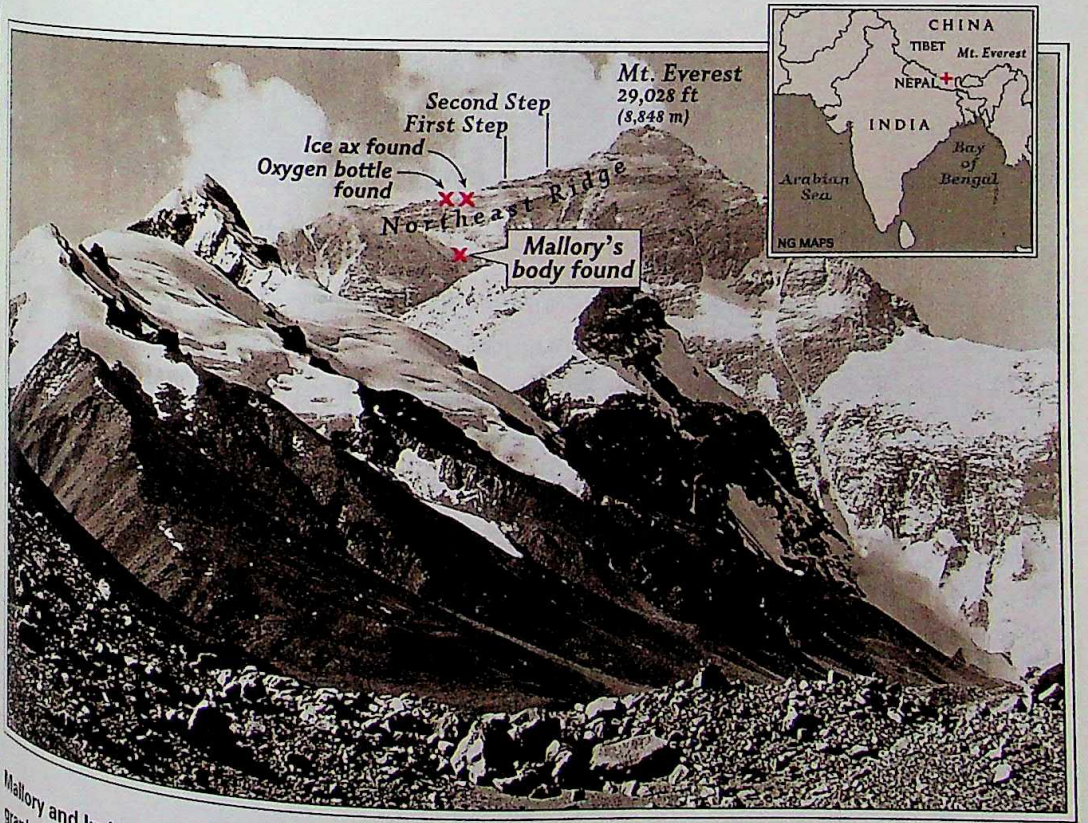
I radioed to Jake Norton, Dave Hahn, Andy Politz, and Tap Richards, who were fanned out across the terrace above me. Jake heard me say "hobnailed" and instantly looked down to see me waving. I tried the others again, asking them to join me for "tea and Snickers." My third call was for a "mandatory group meeting." Soon all four were descending toward the final resting place of George Leigh Mallory.

"He's frozen solid to the rocks," Jake said, as he and Tap carefully chipped at the ice with an ax. There was no way to turn him over. Gently cutting off his shirt collar, Jake held out the label so the rest of us could read the neatly stitched name, "G. Mallory." Reaching under the body, he removed a pair of sun goggles from a chest pocket, from another pocket a handkerchief monogrammed "G. L. M." Under his right arm, Jake found a broken altimeter, scissors, and a pocketknife. In a vest pocket close to Mallory's heart was a packet of letters from his family.

After we searched the body, we covered it with rocks, Andy read an Anglican committal ceremony, and we left Mallory in peace.

Curiously, Mallory was not wearing gloves. Nor did we recover his 1924 Kodak Vest Pocket camera or any other conclusive evidence to answer the big question: Had Mallory been the first person to stand on top of the world? From what we found with his body and from the difficulties I experienced myself in climbing his route to the summit, I think it's highly improbable, for the following reasons:

■ The route is too tough. When Mallory and Irvine were last seen, they were somewhere near the Second Step, a 90-foot-high wall of rock at 28,300 feet. Two weeks after finding Mallory's body, I tried to free climb this sheer wall much as Mallory would have, avoiding a ladder left in 1975. I found it extremely difficult, even with crampons and modern rock-climbing techniques. Climbing roped together without attaching any gear to the rock—standard procedure in their day—would not have gotten Mallory and Irvine up the Second Step.



AUDREY SALKELD COLLECTION

Mallory and Irvine pioneered a route through Tibet to Everest, as seen in this 1924 photograph. Edmund Hillary and Tenzing Norgay first reached the summit, in 1953, via Nepal.

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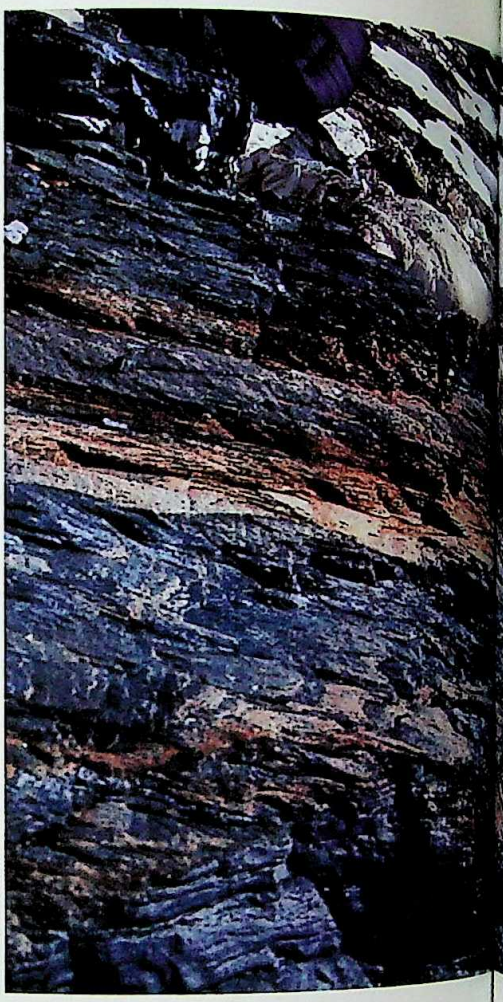
■ Their gear and supplies were insufficient. Without crampons for secure footing and fixed ropes to guide them and aid their descent, Mallory and Irvine would have had to have been superhuman to have summited. Their oxygen apparatus was heavy and prone to malfunction. And their lack of adequate food and drink would have slowed them down and increased their chances for mistakes.

■ The timing was off. They were climbing late in the day. If they had made it to the summit, they would have had to bivouac in the open. But Mallory's nose and fingers were not swollen and discolored by frostbite, which

Calm weather and a light snow season proved lucky for the 1999 expedition. When conditions turned stormy, a Ukrainian climber was stranded near the summit, and the team helped rescue him.

leads me to believe that they did not spend the night outside before dying. To me Mallory's missing gloves are a crucial clue. Having turned back above the First Step, Mallory may have taken off his gloves to grip the steep rock as he descended. I think he probably slipped and pulled Irvine off a ledge. The frayed rope still tied to Mallory's waist may have been cut by an edge of rock, sending him tumbling to the snow terrace, then sliding farther to where I found him.

None of this, of course, has lessened my admiration for Mallory and Irvine. The route they pioneered to the Northeast Ridge in the 1920s is the one most climbed today on the north side. For the two of them to have gotten as high as they did with the resources they had is truly amazing. Whether or not they made the summit, they will forever hold a place as heroes on the world's highest peak. □



A Final Resting Place

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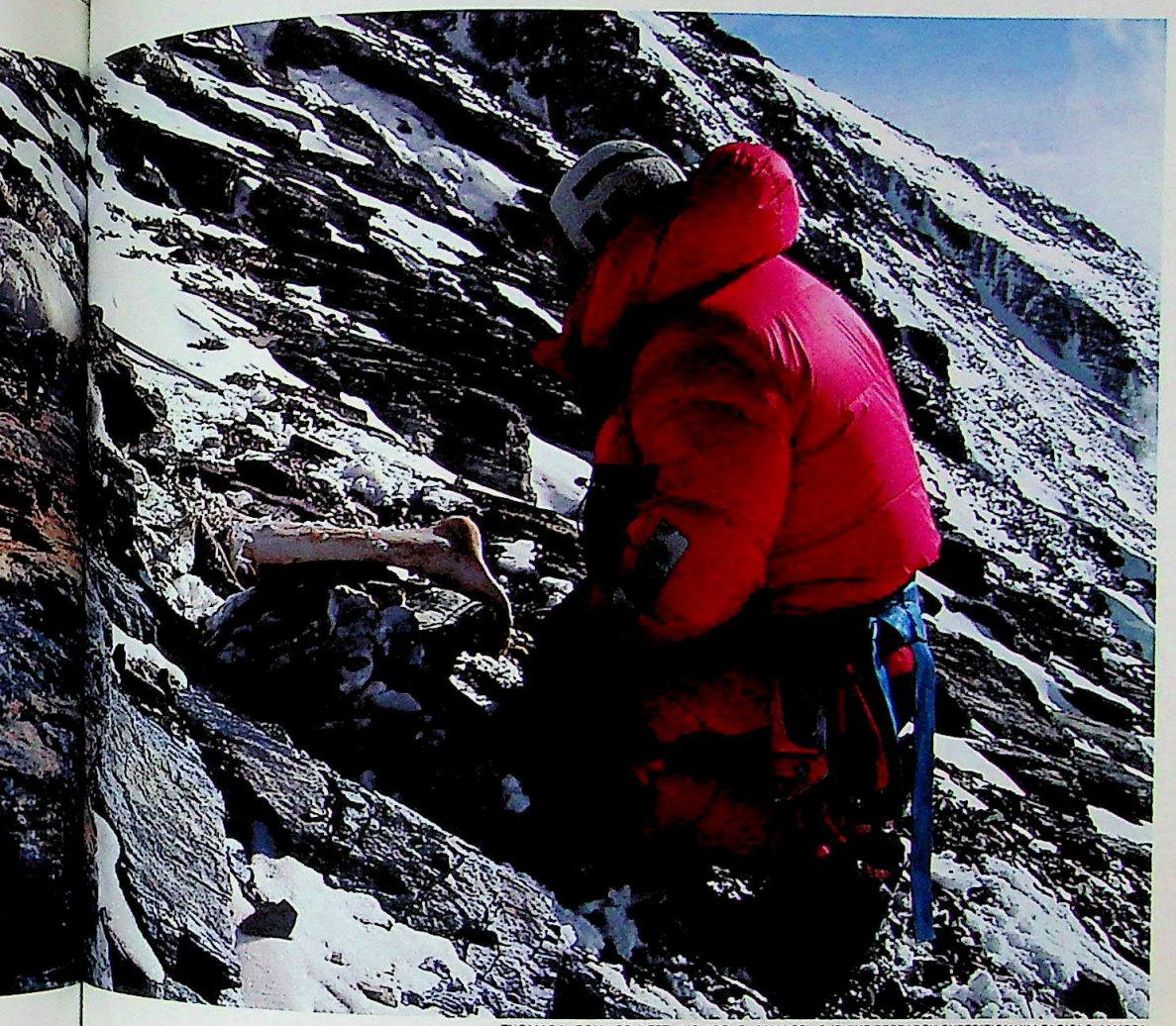

THOMAS H. POLLARD (LEFT AND ABOVE); MALLORY & IRVINE RESEARCH EXPEDITION/JIM FAGIOLO, LIAISON

"WE EXPECT NO MERCY from Everest," Mallory told a friend before his final expedition. When his frozen body was found, Mallory was lying face down with his left leg crossed over his broken right one. A spare glove (left), boots, goggles, and penknife (below) were found with him. So, too, was his circular altimeter, which once recorded altitude near the summit of his ambition. He had written to his wife: "I look upon myself as the strongest of the lot, the most likely to get to the top." To honor that hope, the team interred Mallory's remains beneath rocks, held a brief burial service, and descended the merciless mountain.

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BY PRIIT J. VESILIND • PHOTOGRAPHS BY JONATHAN BLAIR
NATIONAL GEOGRAPHIC SENIOR WRITER

WORLD WAR II IN THE ATLANTIC...
GERMAN U-BOATS...
SECRET CODES... GOLD BULLION...
A RENDEZVOUS AT SEA...
AMERICAN FLYBOYS...
SUDDEN DEATH...
A SALVAGE HUNTER...
THE LUST FOR GOLD...
AND A JAPANESE SUB ON...

THE LAST D

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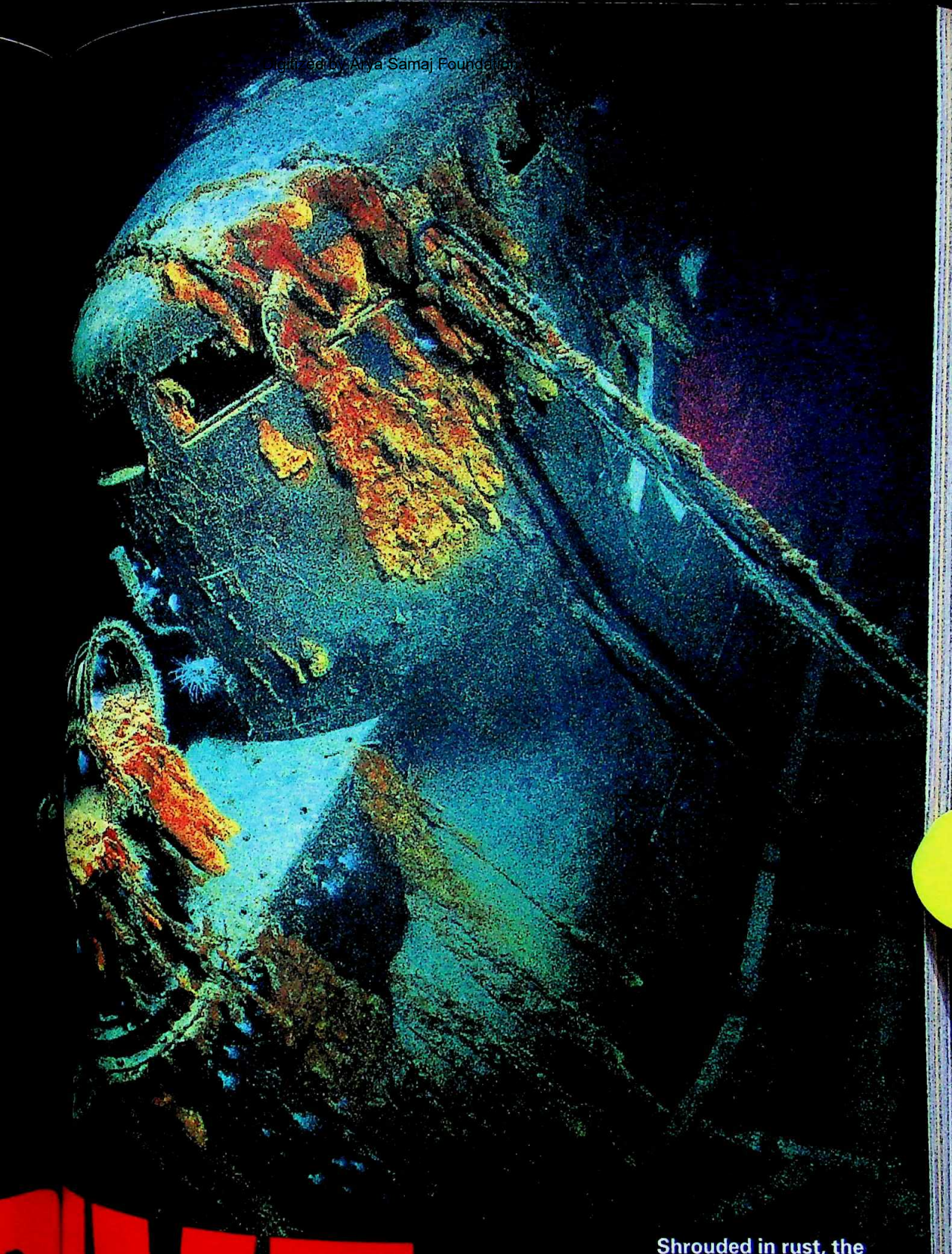

DIVE

Shrouded in rust, the Japanese submarine *I-52* cruises into eternity with 112 souls who rode it to the bottom in 1944. It was sunk by American bombers after surfacing to meet a German U-boat.

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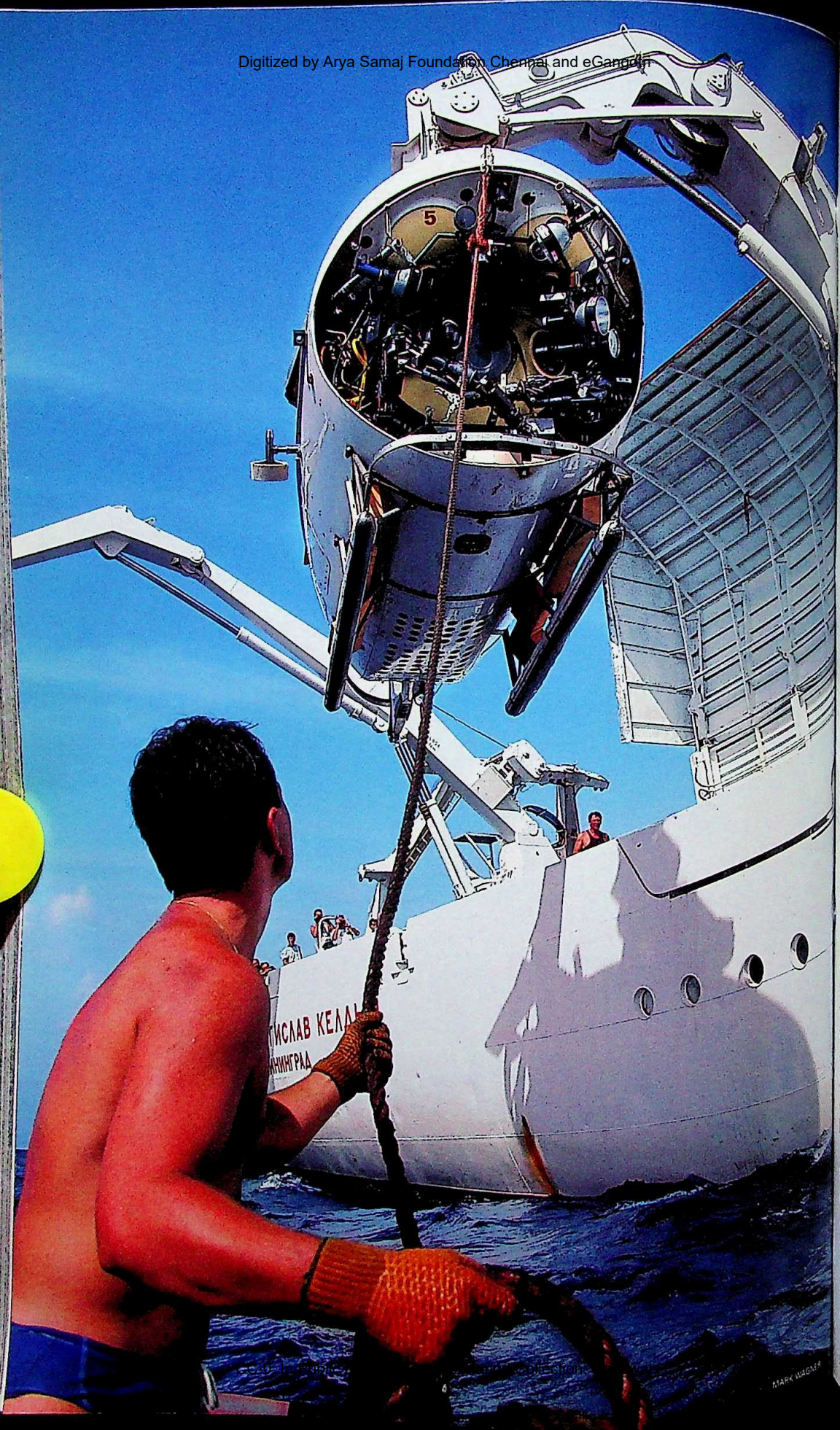

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MARK WAGNER

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1998 There's a lot of time to think when you're falling three miles deep into the Atlantic Ocean, because it takes four hours to reach bottom. And I'm mostly thinking, "Lord, let the ballast pumps work this time."

I'm cramped inside a capsule the size of a '57 Buick, a steel-hulled submersible named *Mir 1*, meaning "peace" in Russian. Beside me are Viktor and Igor, compact, self-possessed men, pilot and navigator of one of the world's most efficient deep-ocean diving systems.

There had been trouble on a previous *Mir 1* dive involving a sticky pump valve. The submersible was stalled on the bottom for an hour and a half and finally had to release its emergency ballast of nickel shot to gain buoyancy. I was on a later dive but figured, "*nyet* problem," as the Russians say. No one's been left on the bottom yet.

Our submersible is one of two carried on the oceanographic vessel *Akademik Mstislav Keldysh*. The *Keldysh* now hovers high above us, carrying 90 Russian sailors and scientists and a group of about 30 Americans, some from Cape Verde Explorations, a company formed by project leader Paul Tidwell. He is a salvager from New Orleans and has chartered the Russian ship for six weeks in the deepest private shipwreck expedition in history—nearly a mile deeper than the *Titanic*.

Viktor looks nervous as we sink below 12,000 feet. My imagination, probably. Cold sweat—no, it's condensation—forms on the walls as if the pressure were punching seawater through metal. We pull on heavy jumpsuits against the 50-degree chill. An hour later *Mir 1* settles onto the bottom like an alien spaceship. I check our position: latitude 15°N, longitude 40°W. We're 870 nautical miles from the Cape Verde Islands, 1,130 miles from Barbados, and 17,190 feet straight down.

Somewhere in the murk nearby lie the remains of a 350-foot World War II Japanese submarine, the *I-52*, sunk in 1944 by American aircraft. It carried a load of rubber, tin, opium, quinine, tungsten, molybdenum, and two metric tons of gold bullion bound for the coffers of the Japanese Embassy in Berlin—146 bars in 49 metal boxes, worth more than 15 million dollars today.

For more than 40 years the wreck might as well have been on the moon. It was beyond reach, its location only roughly known and the details of its sinking locked in classified documents.

By the 1990s advances in deep-sea technology had made three-mile depths accessible, but the *I-52* was still a small sliver in a vast space. Was it in one piece? Was the cargo intact? And was its voyage linked, as some conspiracy theorists suggested, to uranium and nuclear secrets?

For Paul Tidwell, a man fascinated with history yet haunted by it, the *I-52* was a puzzle that had become a passion. He knew that with meticulous planning he might find the wreck, perhaps with those 49 boxes of gold bars strewn around it like coins. Or he might find something less tangible that mattered more.

1944 In spring, when cherry trees were blooming near the Imperial Palace, 34-year-old Satonobu Gamo left home in Tokyo on a mission so secret he could not even tell his

Shuttle to the abyss, the submersible *Mir 2* is lowered from its Russian mother ship, *Keldysh*, for a 16-hour round-trip journey to the *I-52*. Hired by American salvager Paul Tidwell to explore the wreck, pilots from Russia's Academy of Sciences used *Mir 1* and *Mir 2* to take observers to the bottom.

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PRIIT J. VESILIND, NGS STAFF

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For Paul Tidwell, a man fascinated with history yet haunted by it, the *I-52* was a puzzle that had become a passion.

wife, Atsuko. Gamo was an engineer, a father of four. He had been ordered to Germany to visit the Daimler-Benz plant and learn how engines were built for torpedo boats.

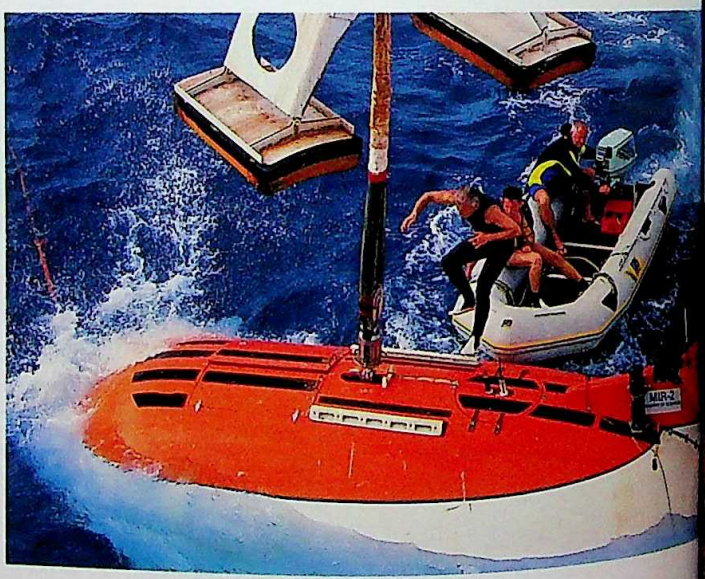
Japan desperately needed new weapons technology from Germany, and Germany needed raw materials from Japan's empire. But the Axis partners were half a world apart, and all routes across Siberia were closed. Japan had signed a nonaggression pact with the Soviets, but Germany was at war with them. At first German merchant vessels carried the *Yanagi* trade, the Japanese code name for this exchange, but surface shipments became virtual suicide runs; by 1944 scarcely half the ships were getting through.

The only alternative was underwater, and soon both Germany and Japan were modifying submarines to carry Yanagi cargo. The *I-52* was completed at Japan's Kure Naval Yard in 1943. It could hold some 300 tons of freight and steam 21,000 miles without refueling. But the cargo subs fared little better than surface vessels: Only one, *I-8*, completed the voyage from Japan to Europe and back.

In mid-March 1944, under Comdr. Kameo Uno, the *I-52* left Kure Harbor. It stopped in Singapore to take on raw material from Japan's Southeast Asian colonies—2.88 tons of opium, 3 tons of quinine for medical use, and 54 tons of raw rubber. It was manned by 11 officers and 84 enlisted men and carried 14 passengers, 6 from the navy and 8 civilians—a translator and 7 engineers, including Satonobu Gamo. The departure from Singapore was duly noted by U.S. intelligence, which had broken the "purple code" of Japanese diplomacy.

A dreary month passed as the *I-52* worked its way through the Indian Ocean. To avoid detection, it surfaced only at night. During daylight the passengers and off-duty crew had to lie flat, to conserve oxygen.

Gamo had written a letter to his son: "I, your father, have been ordered by the nation to go to a distant place in order to complete an important mission so that Japan will be able to win the war. . . . Satoaki, you have to grow into a great Japanese boy. . . . Think what you should do to become strong and wise."



By May 15 the *I-52* had rounded Africa and entered the Atlantic. As a precaution it was ordered to rendezvous with a German U-boat in mid-ocean, to take on a German pilot and a new radar detector, with two men to operate it, that would enable the sub to sneak into the port of Lorient in German-occupied France.

But by this time the Atlantic was an Allied lake. From around its rim, radio-listening stations relayed positions of Axis ships. The Allies had cracked Germany's Enigma cipher, giving them access to German naval messages.

JONATHAN BLAIR photographed his first story for NATIONAL GEOGRAPHIC in 1966; his most recent article, "From Fins to Feet," appeared last May.

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This intelligence, known as Ultra, had already driven the wolf packs of U-boats into hiding, and now it also included the Japanese diplomatic and naval messages to guide Allied antisubmarine forces.

U.S. commanders in Washington, D.C., had pinpointed the *I-52* on a wall chart punctuated with nearly every enemy submarine in the Atlantic. They knew exactly who and what the doomed Japanese vessel carried.

I-52 crossed the Equator on June 4, two days before the invasion of France at Normandy, and got to the rendezvous on schedule at dusk on June 23. The German *U-530* lay in wait.

With both subs surfaced and dangerously exposed, the German commander, Lt. Kurt Lange, launched a rubber dinghy carrying three men—Lieutenant Schäfer, the pilot, and the two radiomen, Petty Officers Schulze and Behrendt—and a wooden box containing the new radar-detection gear. In the heavy swell the box tumbled into the sea, a German seaman later recalled, but a Japanese sailor dived in and retrieved it.

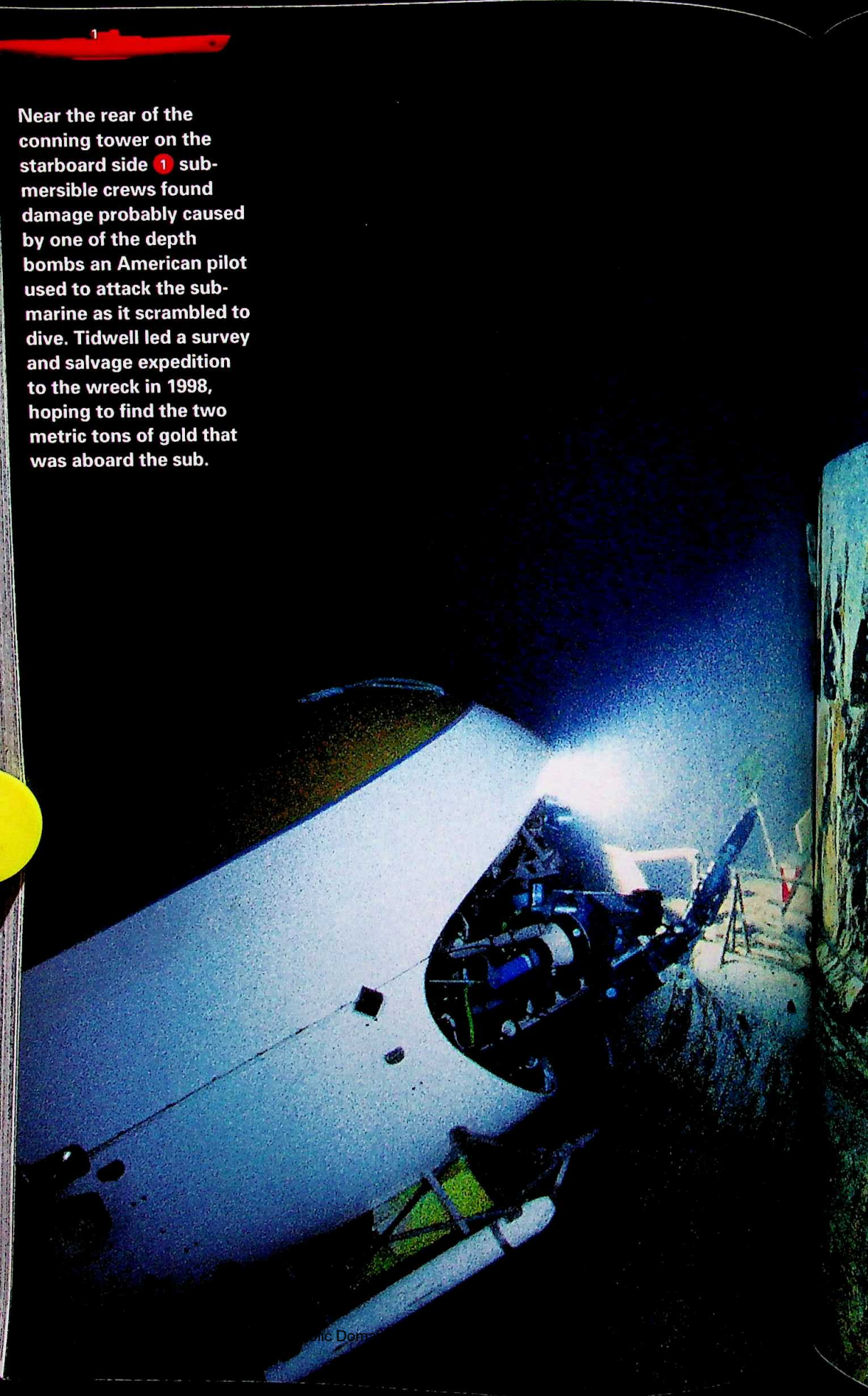
Two and a quarter hours after the subs met, the *U-530* slipped away and set a westerly course. Life and death then hung in the balance as the Japanese submarine stayed surfaced, as if unwilling to give up the luxury of the night air.

Meanwhile 55 miles away Lt. Comdr. Jesse Taylor in his Avenger torpedo plane had been launched from the stubby flight deck of the U.S.S. *Bogue*. The vessel, a bantam-size carrier (CVE) converted from a merchant ship hull, was using information from a special Ultra-guided American antisubmarine command known as the Tenth Fleet.

Taylor, a 28-year-old from Watson, Missouri, was the leader of Composite Squadron 69 (VC-69), one of 14 pilots on the *Bogue* qualified to fly continuous, overlapping night missions. They were *(Continued on page 124)*

Wired to the nerves of *Mir 1*, Viktor Nischeta (below) pilots the submersible up from an encounter with the *I-52*, which lies broken on the bottom at 17,190 feet—more than three miles. Built by the U.S.S.R. in the 1980s for deep-sea exploration, the two *Mirs* can go even deeper and have a good safety record—though nothing on the subs is routine, not even casting off (left). "In a *Mir* you tend to be very, very alert," says photographer Jonathan Blair.

Near the rear of the conning tower on the starboard side 1 submersible crews found damage probably caused by one of the depth bombs an American pilot used to attack the submarine as it scrambled to dive. Tidwell led a survey and salvage expedition to the wreck in 1998, hoping to find the two metric tons of gold that was aboard the sub.



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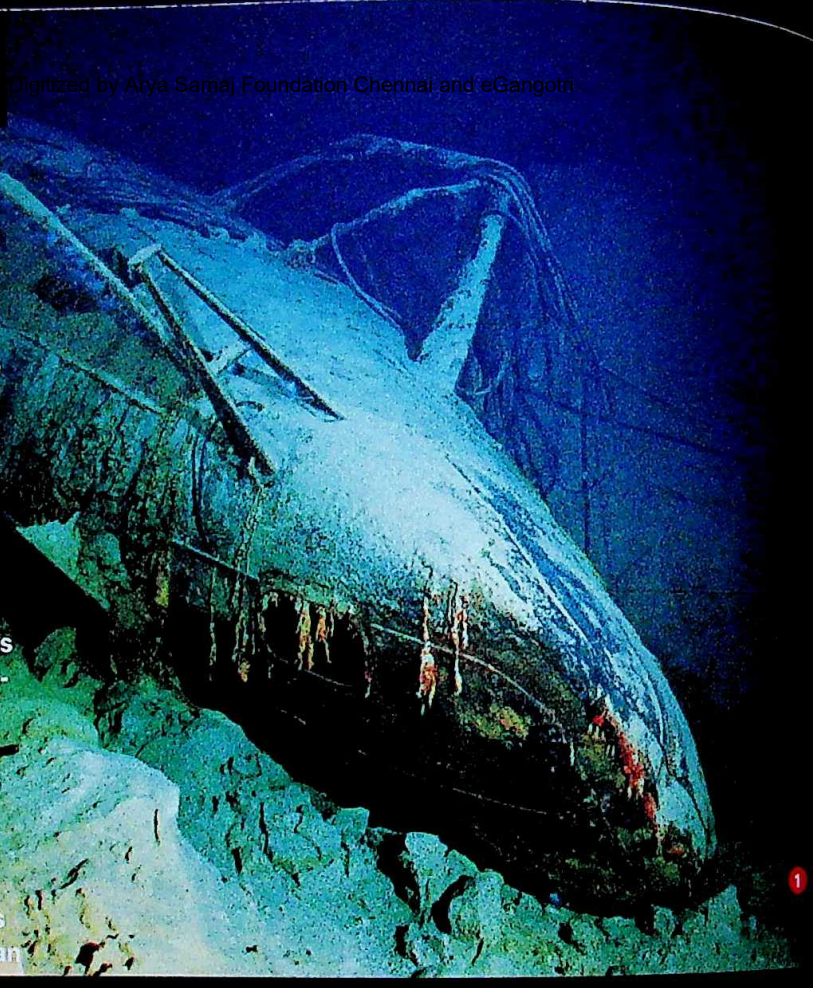
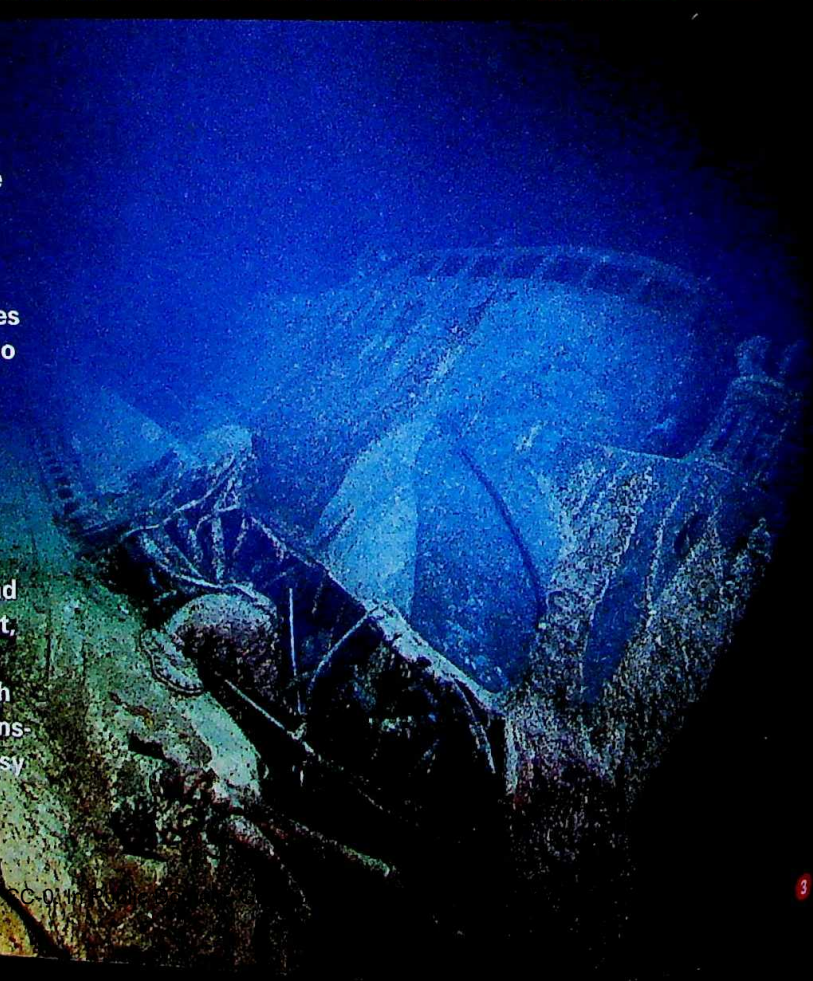
New pieces in a wartime puzzle, these photos of the Japanese sub add detail to a portrait that was almost pure speculation until now. First glimpse of the *I-52* came in 1995, after a team assembled by Tidwell calculated its location from war documents and found it using side-scanning sonar. An image from the 1998 survey expedition shows the sub's largely undamaged stern 1 with its propeller guards still intact. Antiaircraft guns 2 point skyward, as they did while the sub lingered on the surface to recharge its batteries after meeting its German counterpart. Damage to the starboard side of the hull forward of the conning tower 3 probably was inflicted by depth bombs. Some of the worst damage was found in the bow 4 where a tangled mass of wires and hoses marks the sub's torpedo room. The vessel may have landed bow first, crushing this section. The torpedo-shaped objects are tanks that supplied air to the torpedo tubes. Just behind them is a compartment, still intact, that may contain the gold, which the Japanese were transporting to their embassy in Berlin.





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extraordinary young men, sifted from many, with the reflexes to land a plane on a dimly lit and heaving platform the size of a vacant lot.

"Kids. We were just kids," said Snuffy Yarrington, flight gunner on the *Bogue* at the age of 22. "But, boy, did you grow up in a hurry."

The squadron was weary. "We'd been out for seven weeks and were running low on food and fuel," remembered Lt. (jg.) William "Flash" Gordon, another pilot. "This was our last mission before we returned home to Norfolk."

As Taylor soared toward his patrol area, Chief Ed Whitlock, the Avenger's radarman, picked up a promising blip. Closing in, they dropped two smoke lights and a purple sonobuoy into the water. Sonobuoys were newly developed floating radio transmitters that relayed underwater sound to a wire recorder in the cockpit.

The sonobuoy began whispering the "slurp, slurp, slurp" of a marine propeller, and soon the Avenger's crew encountered a startling sight—a huge, fully surfaced enemy submarine, steaming at 10 to 12 knots, tossing a heavy wake.

As the *I-52* scrambled to dive, Taylor roared across its bow, wheeled in a figure eight, and dumped two powerful depth bombs on the starboard beam (opposite). Circling back, he swooped down on the telltale boil of white water to deposit a Mark 24 acoustic torpedo, nicknamed Fido. Three minutes later the sounds of destruction echoed in the thin tenor of the sonobuoy. The gunner, Andy Emmons, said it sounded like "paper being crumpled into a ball in your fist."

The commanding officer of the *Bogue*, Captain A. B. Vosseller, deployed a second attack pilot, Flash Gordon, 45 minutes after Taylor's hit. Gordon dropped his own torpedo after picking up prop sounds at the site, and 17 minutes later he heard a sustained explosion.

The *I-52*—reeling from the detonations, seawater ripping through a gaping hole in its pressure hull, bulkheads collapsing, emergency sirens keening, lights fading into a total and merciful darkness—must have spiraled swiftly down as 112 men made their peace with death.

The following day the *Bogue*'s destroyer escorts found debris and a large oil slick on the water. One of them, U.S.S. *Janssen*, salvaged more than a ton of raw rubber, as well as a sandal and grains of rice. Another picked up silk thread and pieces of flesh.

WILLIAM GORDON COLLECTION

The U.S. Navy sank so many ships in the Atlantic that the Axis powers were forced underwater into cargo-laden subs. A 1944 photo shows one of the teams sent to hit the *I-52*: pilot William "Flash" Gordon, center, gunner Quentin Kelso, left, and radioman Ira Martin.

1995 No photographs of the *I-52* have been identified, and for decades its mission was mired in secrecy on both sides of the war. When reams of U.S. military documents were declassified in the early 1990s, Paul Tidwell was among the first to probe the archives.

The son of a Louisiana businessman, Tidwell is a short, gray-haired, and unassuming man of 50, a veteran of Vietnam with a Purple Heart and two Bronze Stars for combat valor in two tours of duty, including the brutal Tet Offensive. A man of resilience and purpose, he can also be opaque and distrustful.

When his eyes first fell on the words "*I-52* is carrying 2 tons of gold" on a document in the National Archives, he quickly turned the page and glanced around the dusty room to see if anyone had noticed his elation.

By U.S. law a salvager working in international waters can claim rights to a wrecked merchant vessel if he retrieves artifacts from the site, but a country retains ownership of its sunken warships. The Japanese government had claimed at least one other World War II wreck, and Tidwell hoped to avoid a claim to the *I-52*. He traveled to Japan and met with families who had lost loved ones on the submarine, promising them that he would respect the site as a grave.

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ART BY CHRISTOPHER A. KLEIN, NATIONAL GEOGRAPHIC

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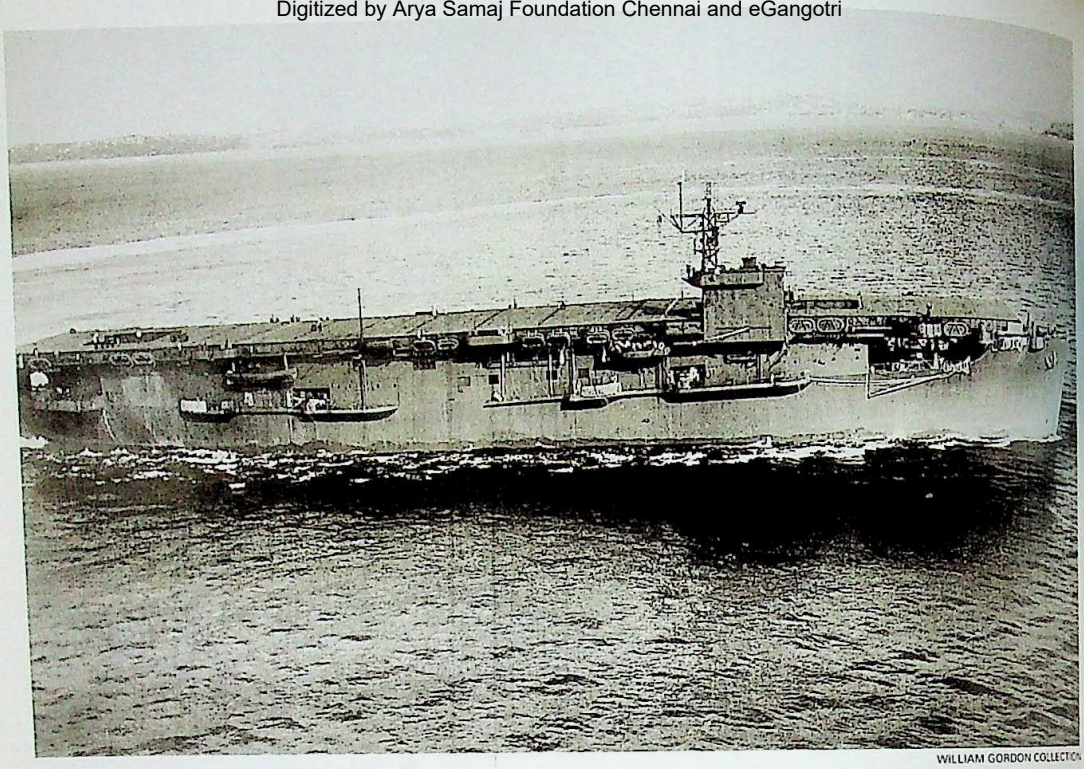

WILLIAM GORDON COLLECTION

Launched from the U.S.S. *Bogue* (above), the air attack on the *I-52* was no fluke. Earlier in the war Allied cryptanalysts had cracked Axis codes, enabling the Navy to monitor communications about the Japanese vessel. Analysts knew that the 350-foot sub, loaded with war matériel, was bound for Nazi-occupied France and that it planned a surface rendezvous at dusk with a Nazi U-boat, the *U-530*. When the subs came up, the Navy was already closing in.

Gradually the treasure hunt became a mission. "I began to get more feeling of the sense of the human tragedy," Tidwell said. "I was really immersed in it."

The timing was right. By 1995 private salvage at great depths was possible because the world's militaries were already dumping their sophisticated Cold War espionage tools—robots, sensors, submersibles—onto the commercial market.

For technical expertise Tidwell contracted with Sound Ocean Systems of Seattle, Washington, which in turn hired specialists from Meridian Sciences. He first took his quest to sea on April 12, 1995, in another hired Russian vessel, the *Yuzhmorgeologiya*. With a technical team managed by Tom Dettweiler, Operation Rising Sun pulled out of Barbados while Meridian's number crunchers were still at work reconstructing the actual routes of the ships and aircraft that took part in the *I-52* action.

For more than two weeks they swept the seafloor with side-scanning sonar. Nothing. Had the *I-52* somehow survived the attack? After a new look at the numbers they tried a sector a few miles to the west. The move was affirmed when a coded message arrived by satellite telephone from Meridian Sciences with reworked coordinates. Money and supplies were low, but the *Yuzhmorgeologiya* pushed on. The sonar printouts on the morning of May 2 revealed a hazy black object surrounded by metal debris, the unmistakable image of a submarine.

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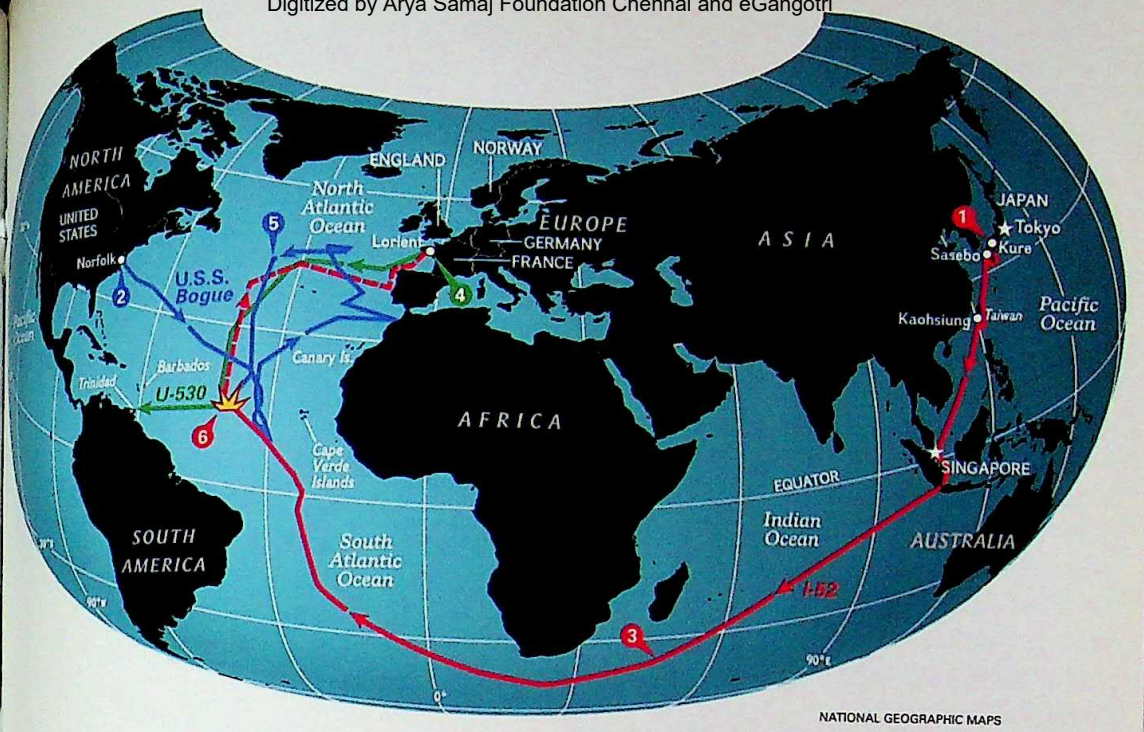


NATIONAL GEOGRAPHIC MAPS

1 **March 1944**
I-52 sails.

2 **May 4**
U.S.S. *Bogue* sails.

3 **May 10**
Allied code breakers begin detailed tracking of *I-52* by intercepted radio signals.

4 **May 22**
U-530 sails.

5 **June 15**
U.S.S. *Bogue* receives orders to change course and proceed to new position to attack enemy ships.

6 **June 24**
I-52 is sunk.

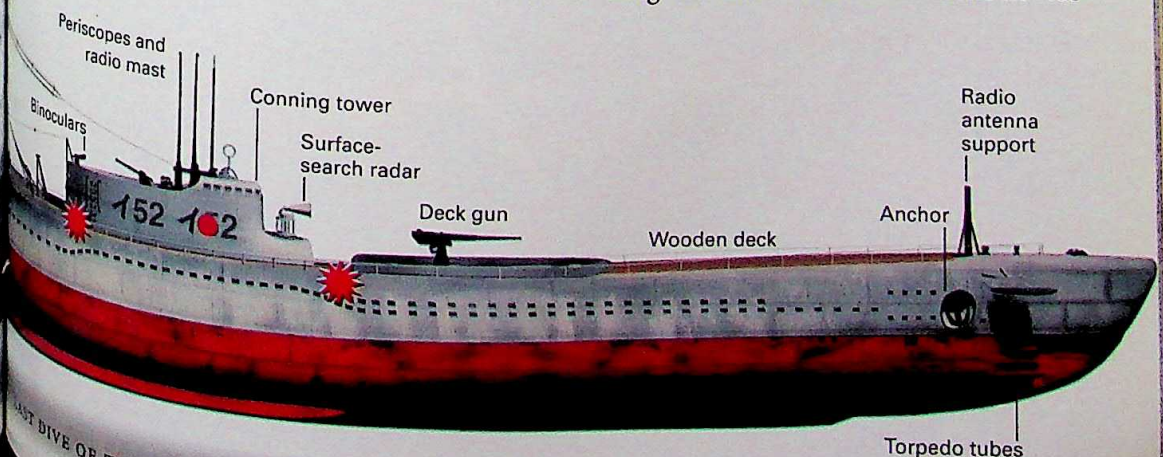
I-52 (Japan)
Intended route of *I-52*
U.S.S. *Bogue*
U-530 (Germany)

"There was no whooping and hollering," remembered Tidwell. "I went up to my cabin and literally collapsed."

The expedition reached home a week later with a cache of photographs, including those of ingot-shaped objects lying on the seafloor. It took Tidwell and his business partner, Guy Zajonc, three years to raise enough money—most of it from James Philippone, a lawyer from Rochester, New York—for a return trip. But the project did not go smoothly.

Tidwell and Zajonc, an attorney from Spokane, Washington, failed in their efforts to find a company to fully salvage the *I-52*. When they settled on the two *Mirs*, it was Plan B: a survey with very limited salvage.

Technical discussions continued to include cutting tools, and money was allocated for them, but Philippone began to feel Tidwell was not leveling with him. "Paul had told me he was



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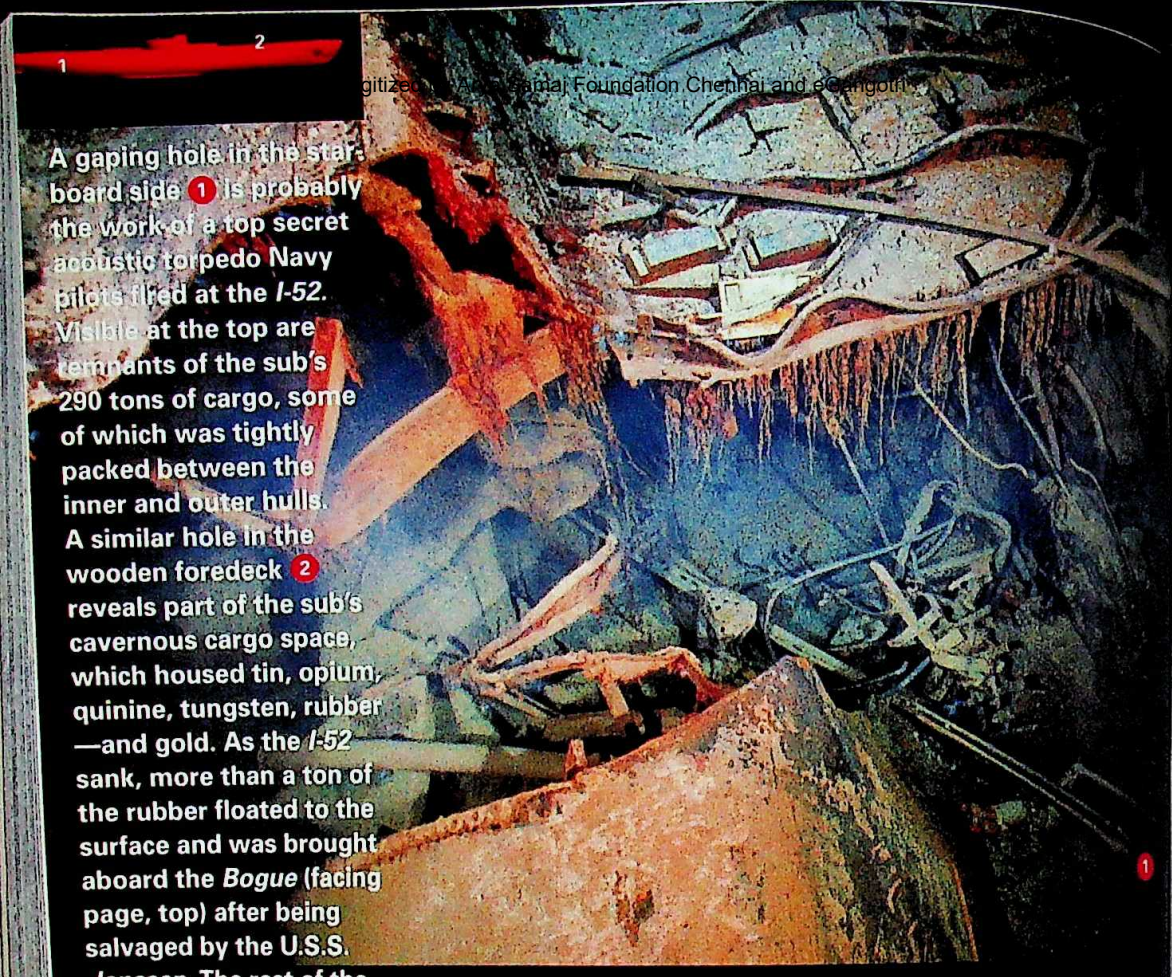

A gaping hole in the starboard side 1 is probably the work of a top secret acoustic torpedo Navy pilots fired at the *I-52*. Visible at the top are remnants of the sub's 290 tons of cargo, some of which was tightly packed between the inner and outer hulls. A similar hole in the wooden foredeck 2 reveals part of the sub's cavernous cargo space, which housed tin, opium, quinine, tungsten, rubber —and gold. As the *I-52* sank, more than a ton of the rubber floated to the surface and was brought aboard the *Bogue* (facing page, top) after being salvaged by the U.S.S. *Janssen*. The rest of the cargo was out of reach until modern technology met the age-old quest for treasure. To defray the cost of exploring the *I-52*, Tidwell recruited supporters willing to gamble that he would recover the gold, worth at least 15 million dollars. When it proved to be beyond his grasp, tempers flared and friendships frayed to the breaking point.

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MARINER'S MUSEUM, NEWPORT NEWS, VIRGINIA

Bogue's destroyer escorts found more than a ton of raw rubber, a sandal, silk thread, and pieces of flesh.

going to buy saws and other salvage gear and go for the gold," Philippone told me later. "But I wasn't seeing any of that in the budget."

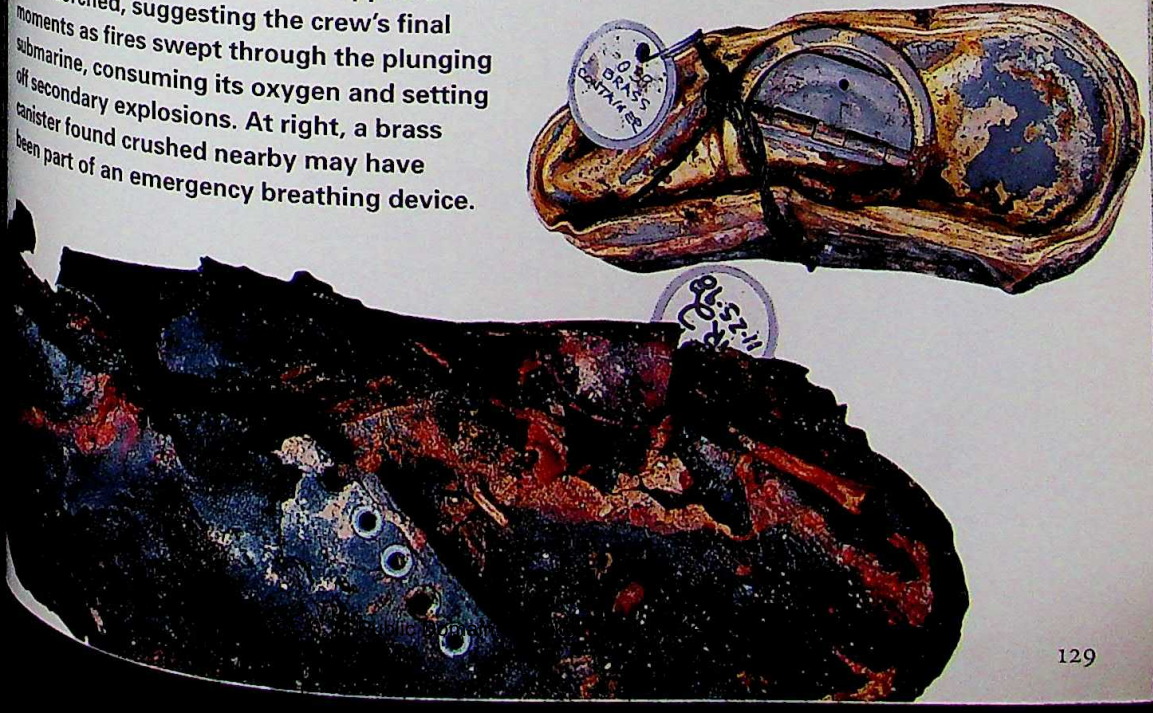
Just as the *Keldysh* headed into Falmouth, England, to be fitted out for our voyage, Philippone backed out. Zajonc hammered out a new budget, and Philippone relented, but he withdrew nearly a third of the funds. Not much salvage capability remained. Tidwell almost canceled. But were there not ingots simply lying on the seafloor? Surely they could pick some up with the *Mirs*' mechanical arms.

When the *Keldysh* left Las Palmas, Canary Islands, on November 8, 1998, it was long on dreamers and short on doers. Tidwell had brought his wife, Jo Anne, and son, Steven. He had hired two security guards—former Navy Seals with bulging arms—and invited veterans from VC-69: Flash Gordon himself, now 77, and two of his shipmates, Snuffy Yarrington and Jack Gamble. But only four experienced technical experts with Cape Verde Explorations were aboard: Marco Flagg, Tim McGinnis, Geof Howe, and Harry Masson, and their skills would quickly have to gel with Russian systems.

On November 20 the *Keldysh* arrived at the coordinates of the sonar image from 1995. In a brief ceremony Tidwell spoke of sacrifice and threw a dark wreath in the water in honor of the Japanese who had died for their country. "We are all sailors," he said. Flash Gordon wept.

1944 Through the summer the Japanese Embassy in Berlin had grown anxious about the *I-52*, which they had code-named *Momi*, or "evergreen." Strategic items for Japan waited at the dock in Lorient: radar units, bombsights, vacuum tubes, optical glass, steel ball bearings, mercury, machine-gun ammunition, alloy steel for aircraft motors, chemicals, platinum, and at least two newly developed T-5 acoustic torpedoes. Diplomats too were scheduled to return to Japan on the *I-52*.

But the sub's due date, July 25, slipped past, and hope was fading when, on July 30, came a prearranged coded radio signal, QWF—ostensibly from the *I-52* but possibly misinformation from the British—that meant it was 36 hours from port. The assistant naval attaché in Berlin, Yoshikazu Fujimura, had already left Berlin with eight Japanese officials to greet the



A shoe recovered near the wreck appears to be scorched, suggesting the crew's final moments as fires swept through the plunging submarine, consuming its oxygen and setting off secondary explosions. At right, a brass canister found crushed nearby may have been part of an emergency breathing device.

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submarine. Encouraged by the QWF signal, they reached Lorient on July 31.

"The most impressive thing was that there were about 200 members of the Hitler Youth in Lorient," Fujimura told Seiichi Nakata, a Japanese television executive, in 1986. "In particular . . . German girls in their early twenties looking very fresh and energetic."

A German warship steamed out of the harbor to meet the Japanese sub. For four days it stood by. On August 8 the naval attaché, Admiral Kojima, radioed Commander Uno from Berlin. "Though we have had no communication from you, we pray for your safety. As it has become dangerous . . . to enter Lorient or other ports along the French coast, proceed to either Trondheim or Bergen in Norway."

By then Allied troops had surrounded Lorient, and Fujimura was in a quandary. "There was no way out except performing hara-kiri. . . . When I said to my juniors, 'What do you think?' they were rubbing their bellies and said that it would hurt."

The Japanese decided to make off in a bus. After a harrowing week-long trip through Allied tank lines, they arrived in Paris on August 8.

Three days later Vice Admiral Abe, Japan's representative to the Axis's Tripartite Council in Berlin, radioed Tokyo: "The disaster which has befallen these liaison submarines one after another, at a time when they were playing such an important role in transportation between Japan and Germany, is indeed an extremely regrettable loss to both countries."

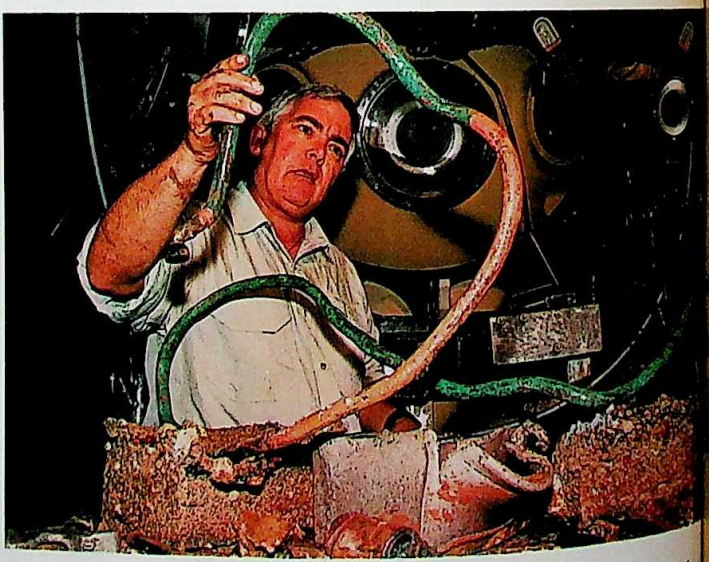
When he was asked about the gold, Fujimura commented, "I do not regret losing . . . gold. I regret that we lost about a hundred sailors. Even now, I wish I could salvage the bodies."

1998 Flesh and bone disintegrate rapidly at such depths; we will not find the bodies. On November 21 Tidwell descends on the first dive in *Mir 2* with two Russian pilots. In *Mir 1* are Marco Flagg and Anatoly Sagalevitch, director of the Russian submersible program. Their mission is to plant acoustic transponders to create an electronic grid to plot key artifacts.

Before the dive Natalya Tumantseva, Anatoly's wife, pushes her way to the railing that overlooks the launch pad. "This is my place," she says. "I've been standing here every time he goes down." She doesn't smile when Anatoly disappears down the hatch with a quick thumbs up. For the Russians, the Tidwell expedition means survival. "For eight years we've been hanging by a thread," she tells me, "with no support from the government, at the end of the food chain."

Sixteen hours later the two submersibles return in triumph: We are on target. "Spooky, overwhelming," says Tidwell.

Tidwell has brought up a brick-shaped metal box from the site. That night, behind closed doors, his security men pry it open.



Salvaging what he can from a thwarted quest for gold, project leader Paul Tidwell (above) examines debris from the sub collected by the *Mirs'* mechanical arms. Hearts raced when a *Mir 1* camera found heavy ingots (right) strewn about the wreck—then sank when they were found to be tin.

"Opium," he says next morning. Picturing the *I-52*'s opium as intact and salvageable, he sees a problem. "If all that opium is brought up and made into heroin, it will have a street value of a hundred million dollars. The State Department and the Drug Enforcement Administration know we're diving." Tidwell dumps the substance overboard.

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The ship is awash in acrimony, and shouting matches erupt. At tea Tidwell tells me laconically, "I'm on vacation."

On the day of my dive photographer Jonathan Blair, who has been down twice in the submersibles, helps me with a white jumpsuit. The crewmen nod their respect, and Zoryana, the young stewardess, smiles. This morning I am *the one.*

We are hoisted off the ship at 10 a.m., and at 2:23 p.m. we're at the bottom of the sea. Viktor checks the gauge for the water ballast pumps. They're flashing the wrong numbers. He pushes buttons and stares at the numbers, pushes and stares. We're sitting on the bottom, and Viktor doesn't know enough English to reassure me.

"Nyet problem," he says, but his face appears grimmer and grimmer. I think of the backup systems. I draw a picture of pieces of nickel shot, which should be released to gain buoyancy. "Only in emergency," says Viktor. Good, this is not yet an emergency.

By 3:30 Viktor is satisfied, and we at last lift off and float over the debris field: scrap metal, cables, dishes. Suddenly a hulking, nearly intact submarine lies below us, canted against a bank of sediment, much of the wooden deck still in place. The rising sun of the Japanese flag is still clearly visible on the conning tower.

The sub's bow is sheared off near the area of the torpedo tubes, probably from striking the bottom bow first. Forward of the conning tower there is depth-bomb damage, a 15-yard-long cavity of shattered innards: twisted pipes, snapped cables, bent girders. But the mortal wound seems to be near the stern, where a torpedo has blasted cleanly through both the outer and the inner hulls.

As we hover above the submarine, *Mir 2* approaches. We are there in part to provide backlight for the IMAX-format film being shot from the other submersible. "We play Marlon Brando for IMAX," says Viktor, amused and suddenly verbal.

For the next eight hours I scribble notes, take photographs with the still camera bolted onto the mechanical arm, log coordinates of artifacts on the navigation computer, and stare out the port at history's sad residue. At 3 a.m. we are back on the surface.

Days pass. Tidwell and the salvagers spend the first few weeks surveying, but gold is in their eyes, and disappointment mounts as *Mir* after *Mir* returns with nothing but metal boxes, blocks of rubber, odds and ends. The ingots turn out to be tin. Zajonc says, "We need to bring up 40 gold bars to pay off investors." But the gold must be inside the sub, perhaps below its conning tower.

On November 26, Thanksgiving Day, the chef fixes turkey, with the Tidwells assisting. The Philippones help serve it.

Only three more dives are planned. On November 29, Tidwell takes down a flag, a Japanese naval ensign, that he wants to attach to the *I-52.* Millions of lost dollars swim by Philippone as the *Mirs* surface with empty baskets. No gold, and Tidwell's making symbolic gestures. "I'm wasting time," says Philippone.

Now the ship is awash in acrimony, and shouting matches erupt. At tea Tidwell tells me laconically, "I'm on vacation. Jim Philippone has taken over the dives. He says it's his money."

But the next dive, under new management, fails to bring up any loot, and the final dive is needed to retrieve transponders. As we steam back to the Canaries, the estranged partners and the Russian boss are threatening lawsuits. Sagalevitch pulls Tidwell out of a meeting one evening: There's the matter of an unpaid $30,000 port fee in Las Palmas. Not me, says Tidwell, I don't control the money any more. It's Philippone. Bull-hockey, says Philippone.

"Then we go to Kaliningrad," says Sagalevitch, threatening to take the ship back to the *Keldysh*'s home port on the Baltic Sea.

Not long before midnight Tidwell takes a 70-millimeter underwater camera, replacement cost perhaps $30,000, to Sagalevitch's quarters, "as a gift," he tells me. The Russian answers the door in his bathrobe: "Get out of

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my office, and lose my address!" Tidwell walks out on deck and chucks the camera overboard.

But cooler heads prevail, and we avoid Christmas in Russia. One evening Tidwell says to me, "In a way I'm glad we didn't recover any gold, because it would tarnish the trip. I can walk away proud because I was able to put the flag on. That meant a lot to me."

Exhaustion peers from his eyes, exposing the truth: For him the treasure hunt has turned into a voyage of contrition. The killing fields of another Asian nation haunt Paul Tidwell. He has done some of the killing. Is it absolution he seeks?

"I'm a nice, slow-talking southern boy," he says softly, "but when I was in Vietnam, I was a different person. Some of my buddies didn't make it back, and I had to write to their mothers. For any country to send out their youth to be killed in wars is terrible. This flag was my letter to those families in Japan."

1944 Before they fled Lorient, German troops destroyed much of the cargo intended for the *I-52*. But one item was not spelled out on the destruction list, which said simply, "__oxide 500 kilograms."

"Obviously uranium oxide," says Tidwell, filling in the blank. If the *I-52* had picked up its cargo, the uranium could have reached Japan by the winter of 1944 and been used in weapons development, though not to build an atomic bomb, as some feared at the time.

Both the Germans and the Japanese had atomic research initiatives, but Hitler curtailed Germany's efforts because he foresaw a quick victory and felt the program would be too costly. The Japanese were trying to find a method to enrich uranium but were in a very early state of this research. Neither was close to building a bomb.

Still, Japan wanted high-grade uranium oxide and depended on Germany to get it. There is evidence that in 1944 a German submarine delivered 500 kilograms of the mineral, but another 500 kilograms was lost at sea on its way to Japan.

The last shipment of uranium left from Kiel March 25, 1945, in a large mine-laying German submarine, *U-234*, under Lt. Johann-Heinrich Fehler. It carried the last of the Yanagi shipments out of Europe—weapons, ammunition, metals, and a disassembled Messerschmitt 262 jet fighter. Mercury and lead were packed in as keel ballast, and in the bow were ten cylinders of uranium oxide.

Among the 12 passengers was Luftwaffe Vice General Ulrich Kessler, the new air attaché to Tokyo, as well as two Japanese technical officers, Comdr. Genso Shoji and Comdr. Hideo Tomonaga, who had been with the delegation sent to Lorient to greet the *I-52*.

On May 8, after the *U-234* had passed from the Norwegian Sea into the North Atlantic, Germany surrendered, and the order came to turn

The Deepest Dive

"It was like going to the moon, only underwater," says photographer Jonathan Blair, standing at far right, after the expedition. "Climbing aboard the *Mir* was like saying good-bye to the world. And once you're down at 17,000 feet, it's very easy to feel as if you're lost in space." Making pictures, of course, was the real challenge for Blair, who has been shooting for the GEOGRAPHIC for more than 30 years and calls this "the toughest trick I've ever tried." To make pictures at this depth and pressure, Blair mounted a heavy-duty Benthos camera loaded with fast film on one of *Mir 1*'s manipulator arms. Using a video monitor to position the camera and lights, he shot about 1,500 still images of the *I-52*. Experts studying Blair's pictures believe they have determined the exact sequence of explosions that brought down the sub.

NOBUKO HANO COLLECTION

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Satonobu Gamo left home in Tokyo on a mission so secret he could not even tell his wife, Atsuko.

back to Norway. But Fehler liked his chances better in America and turned his boat and its lethal cargo toward the west.

Japan was still at war, and Fehler confined Tomonaga and Shoji to their quarters. They were found, as Wolfgang Hirschfeld, a radioman on the *U-234,* describes in a memoir, "lying in adjacent cots, their arms linked, breathing stertorously, and couldn't be awakened." An empty bottle of Luminal sleeping tablets was found nearby. After they died, Fehler had the Japanese wrapped in cloth hammocks with Tomonaga's samurai sword and committed them to the deep.

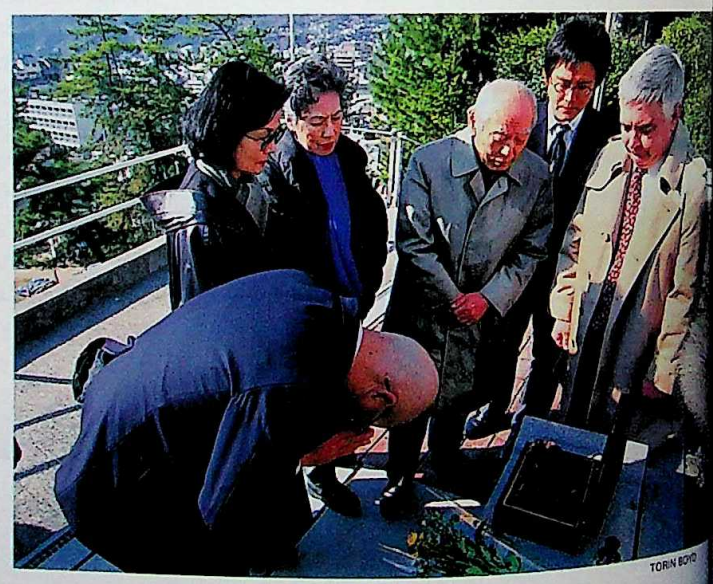
On May 14 the *U-234* surrendered to the U.S.S. *Sutton.* At Portsmouth Naval Base in New Hampshire the arrival of the German U-boat on May 19, 1945, was a sensation. Among the waiting newsmen was William M. Blair of the *New York Times,* Jonathan Blair's father.

Describing the disembarkation of General Kessler, Blair wrote, "Clad in an immaculate gray coat that reached almost to his polished boot tops and a high peaked officer's cap, he appeared almost regal as he stepped to a waiting bus. . . . His cold steel gray eyes, one of them slightly squinting from wearing a monocle, roamed over the guard of Marines. . . . A half-smile was on his lips."

Scientists searched the sub, and on May 27 the office of the chief of naval operations sent a secret memo to naval facilities in New York, describing the cargo as "uranium oxide loaded in gold lined cylinders."

Gold linings were used to protect against radiation leakage but never to pack simple uranium oxide, which is inert and will not emit radiation unless enriched in a fission reactor. Historians agree that Germany did not have such a reactor and that Japan, years away from building an actual bomb, would have no practical use for irradiated material. Why uranium oxide in gold-lined cylinders? It has been suggested that it was a way to transport gold out of the crumbling Third Reich, but no one really knows.

The uranium from the *U-234* was reported to the Manhattan Project, which was frantically developing the first atomic bomb for the United States. But the quantity involved was "of negligible importance for military purposes," according to a 1946 Allied assessment. It almost certainly did not go into the bombs dropped on Japan in August 1945; it was stored in a Brooklyn warehouse that July.



TORIN BOYD

1999 From *Mir 1*'s porthole I had seen the shoe on the bottom of the ocean, a brown lace-up covered with burn marks. Paul Tidwell later picked it up on one of his dives. Now he is by the harbor at Kure, Japan, standing beside a monument to lost submariners. With him are members of the Association of the Bereaved

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Families of *I-52*, relatives of those lost on the sub. He gives them the shoe, along with two others, to place in a museum.

In Japan the loss of the *I-52* is cold, sad history, but Tidwell's revelations are well received, for here, as in America, the sinking had at first been a secret. Notice of the death of Satonobu Gamo, the engineer who perished in the sub, reached his wife a full year after he left home.

In the U.S. the mission was heralded as the first coordinated kill of a submarine using sonobuoys and acoustic torpedoes. The Navy awarded both Taylor and Gordon the Distinguished Flying Cross for the action and used both of their wire-recordings to train pilots.

But a preliminary analysis of Gordon's original wire, conducted last March, suggested to experts at the Applied Physics Laboratory of Johns Hopkins University that the explosive roar Gordon heard was the torpedo itself, self-destructing, and that the propeller sounds were not those of the *I-52* but actually those of the fleeing German submarine. Taylor's attack probably was enough.

For Paul Tidwell the hunt goes on, despite the project's wake of unpaid bills and stranded investors. "I've been talking to the Japanese government and several major Japanese corporations," he tells me. "We're forming a consortium of companies. We may cut away the conning tower and bring it up."

Gold is still the lure, of course. Delivering it was the mission of the 1944 voyage, recovering it the goal of the 1998 expedition. But salvage will be an enormous undertaking, perhaps more costly than the potential payoff. The gold is there but teasingly beyond reach, beyond the four-inch-thick acrylic of the *Mir* porthole, beyond bone-crushing water pressure, beyond two layers of steel plate. Still no closer than the end of the rainbow. □

Ceremonies honored the dead of the *I-52* both above and below the waterline. On one *Mir* dive Tidwell had a Japanese naval ensign attached to the submarine. Several months later he journeyed to Japan to meet the families of the men who perished. In a brief observance at a memorial to lost submariners in Kure, Japan (left), he presented grieving relatives with three shoes—the only personal effects his expedition recovered.

TORIN BOYD

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G. M. KER

■ FROM THE GEOGRAPHIC ARCHIVES

Cryptic Passage

The dead didn't rest in Guanajuato, Mexico. Because of limited space at the Panteón Santa Paula cemetery, the bodies of the poor stayed buried just five years unless relatives paid a grave tax. Corpses with accounts in arrears—perhaps mummified by the region's dry climate—were disinterred and hung on pegs, and their old graves were filled with new occupants.

Writer Frank H. Probert reported on the practice in his July 1916 article on Guanajuato. "A winding stair leads to the crypt, where ghastly, mummified remains are placed in a ghostly row, grinning resentment at the curious." Though probably purchased for Probert's article, this photograph has never before been published in the magazine.

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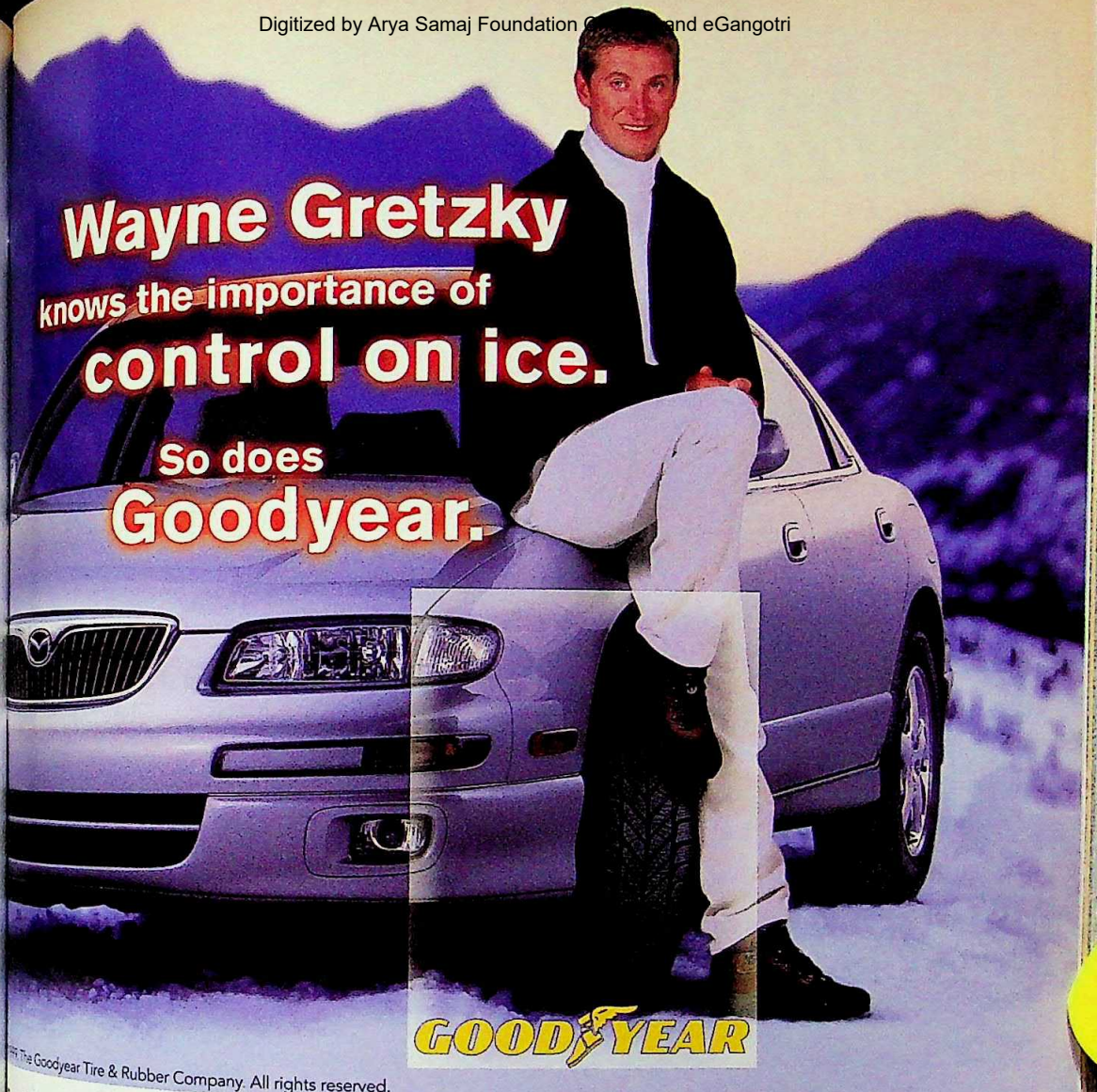

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Behind the Scenes

BOTH BY MARIA STENZEL

One Bee at a Time for This Year's Winner

La Niña affected more than weather this year; knowing the name of that climate system also clinched the National Geography Bee championship for David Beihl, 13, of South Carolina (above, with parents Penny and Gary), whose prizes are a $25,000 scholarship, a lifetime Society membership, and a trip to Australia donated by corporate sponsor Bank One. David spent months studying geography for the Bee, but that is not the homeschooler's only strong subject. The week after his victory David competed in the National Spelling Bee. Though he placed 22nd there, he was already a winner in our book.

How To Be in the Bee

Some of this year's contestants offered their tips for success in reaching the National Geography Bee:

Spend a lot of time with maps and atlases. —SARAH SOLOMON, VT.

Get examples of previous Bee questions off the National Geographic Society website. —MICHAEL OH, N.Y.

Read! Not just atlases but newspapers and magazines too. —ERIC RODAWIG, S.D.

Be sure to answer all the questions right. —TIM CARR, VA.

Family Tradition

This year's youngest National Geography Bee contestant was also one of this year's best. Ten-year-old Mallika Thampy of Maryland Heights, Missouri, made it to the final rounds. It runs in the family; her brother Eapen represented their state in the 1997 and 1998 Bees.

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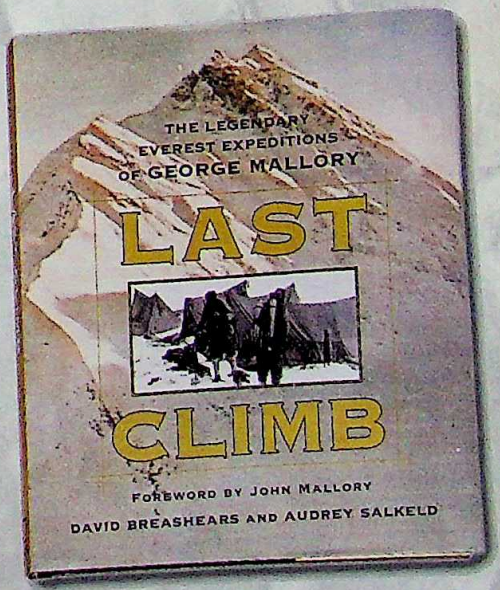
ON EVEREST, ALL THAT KEPT MALLORY WARM WAS THE TWEED ON HIS BACK AND THE FIRE IN HIS HEART.

75 years ago, mountaineer George Mallory, equipped with little more than courage and a passion for adventure, embarked on one of the most ambitious endeavors in history — to be the first man on Earth's highest summit. Now, renowned adventurer David Breashears, co-director of the ground-breaking film *Everest,* and acclaimed Everest historian Audrey Salkeld relive all three of Mallory's daring expeditions with evocative storytelling and spectacular, previously unpublished archival photography. Included are dramatic images of the artifacts recovered during the 1999 Mallory and Irvine Research Expedition. Look for *Last Climb* wherever books are sold or call 1-888-647-6733.



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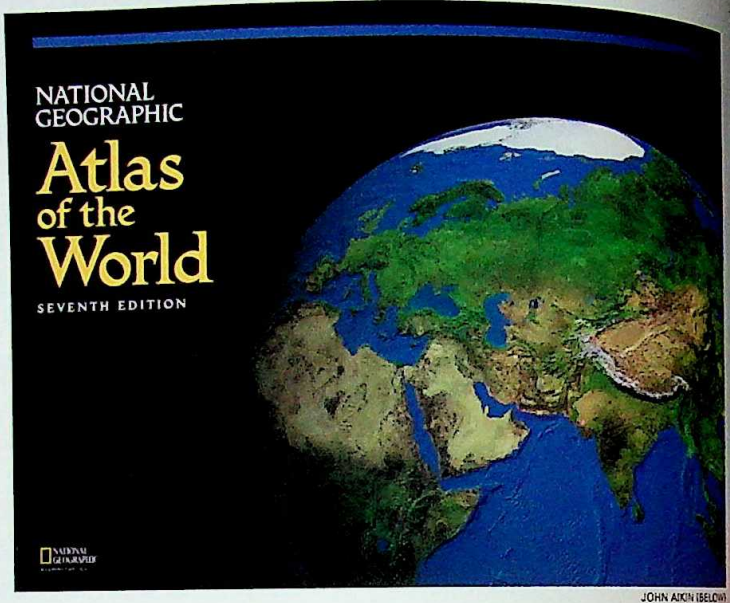
The World on His Shoulders



JOHN AIKIN (BELOW)

Eric Lindstrom, NG Maps' editor in charge of quality control for the new seventh edition of the *National Geographic Atlas of the World*, has spent the past few months waking up earlier than usual, his head buzzing with place-names.

"So many spellings have changed since the last edition," says Eric. "They have to be updated everywhere they appear, and some appear in many different places."

Eric should be used to this by now; the 15-year Society veteran also worked on our sixth-edition atlas, where he and his colleagues made some 3,000 changes by pencil to the index alone. This time the work has been put into an extensive computer database, enabling NG Maps to produce the volume about twice as fast as its predecessor. Future updates will be even easier, and Eric Lindstrom will have fewer restless nights.

The Yorkie Doodle Dandy

Our April 1999 EXPLORER feature *Battle for Midway* prompted a letter from a veteran with a shaggy-dog story. Serving in the South Pacific during World War II, Bill Wynne acquired a tiny dog that had been found in a New Guinea foxhole. "Smoky" was soon a favorite at field hospitals; she once even helped pull phone cables through a 60-foot underground culvert. Her breed was a mystery until the April 1944 GEOGRAPHIC arrived at the camp. That issue's article on toy dogs featured a champion Yorkshire terrier—then ranked low in the American Kennel Club's popularity polls—that was a ringer for Smoky.

International GEOGRAPHICS

Three new local-language editions join our lineup this fall, bringing the total to nine. Faithfully translated from the English-language GEOGRAPHIC, but with added features to arouse local interest, the Polish, German, and French editions will appear on newsstands this month.

TEXT BY MAGGIE ZACKOWITZ

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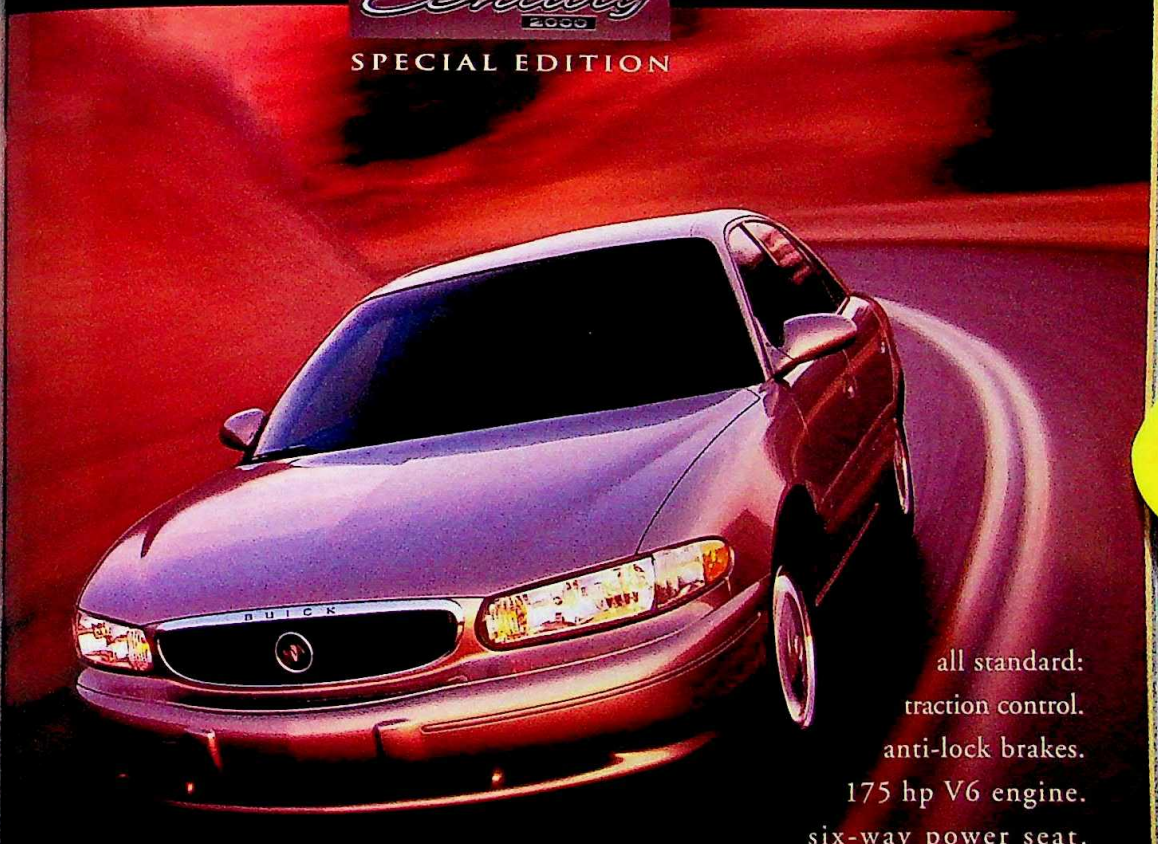

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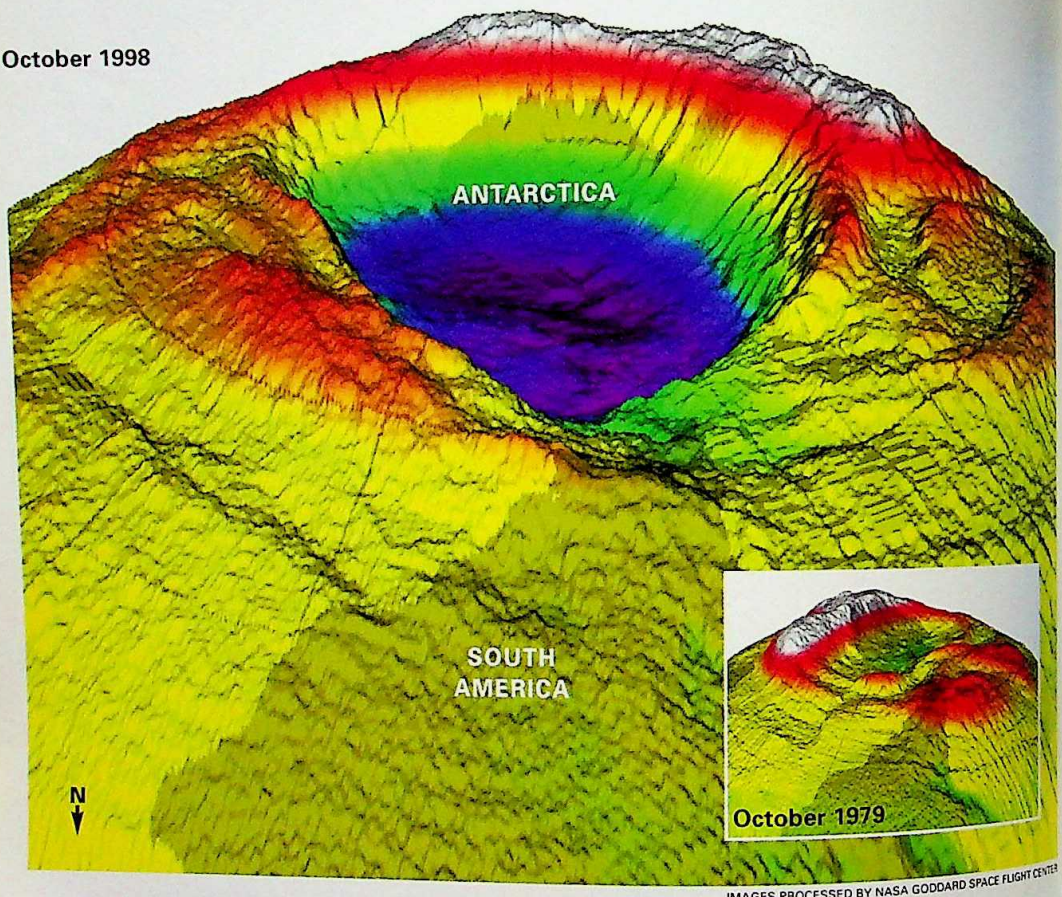

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An Ominous Ozone Hole Looms Above Antarctica

Maps usually depict familiar, visible features like mountains and cities. But maps can also reveal invisible—and sometimes disturbing—phenomena.

What appears to be a crater (above) is actually a 3-D image of the Antarctic ozone hole. Created by NASA's Goddard Space Flight Center, the image depicts low atmospheric ozone levels (the so-called hole) as purple depths and high levels as snowcapped peaks.

For over 20 years a satellite instrument called TOMS (Total Ozone Mapping Spectrometer) has mapped the annual ebb and flow of the ozone layer. Since 1979 (inset) TOMS has shown the hole growing steadily larger.

Ozone levels above Antarctica have been monitored since the 1950s, but the rapid growth of the hole during the 1970s and early '80s caught scientists by surprise. The experts knew that chemicals such as chlorofluorocarbons (CFCs), used as refrigerants, react with sunlight in the upper atmosphere to release chlorine atoms. They also knew that those atoms destroy the ozone that protects Earth from harmful solar radiation. But all that was supposed to happen in bright sunshine, not in the winter gloom above Antarctica.

By the late 1980s scientists had an explanation: After doing initial damage to ozone, chlorine atoms become chemically locked within harmless molecules. Some of these collect over Antarctica, where during the winter they come into contact with icy polar clouds and change into less benign forms. The return of sunlight in the Antarctic spring spurs another reaction, setting the chlorine atoms free to continue their destructive cycle.

TEXT BY ALLEN CARROLL
Chief Cartographer

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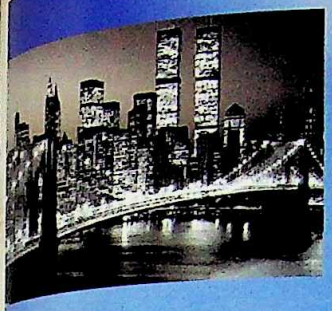

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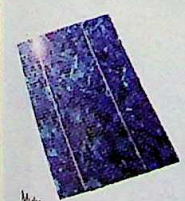

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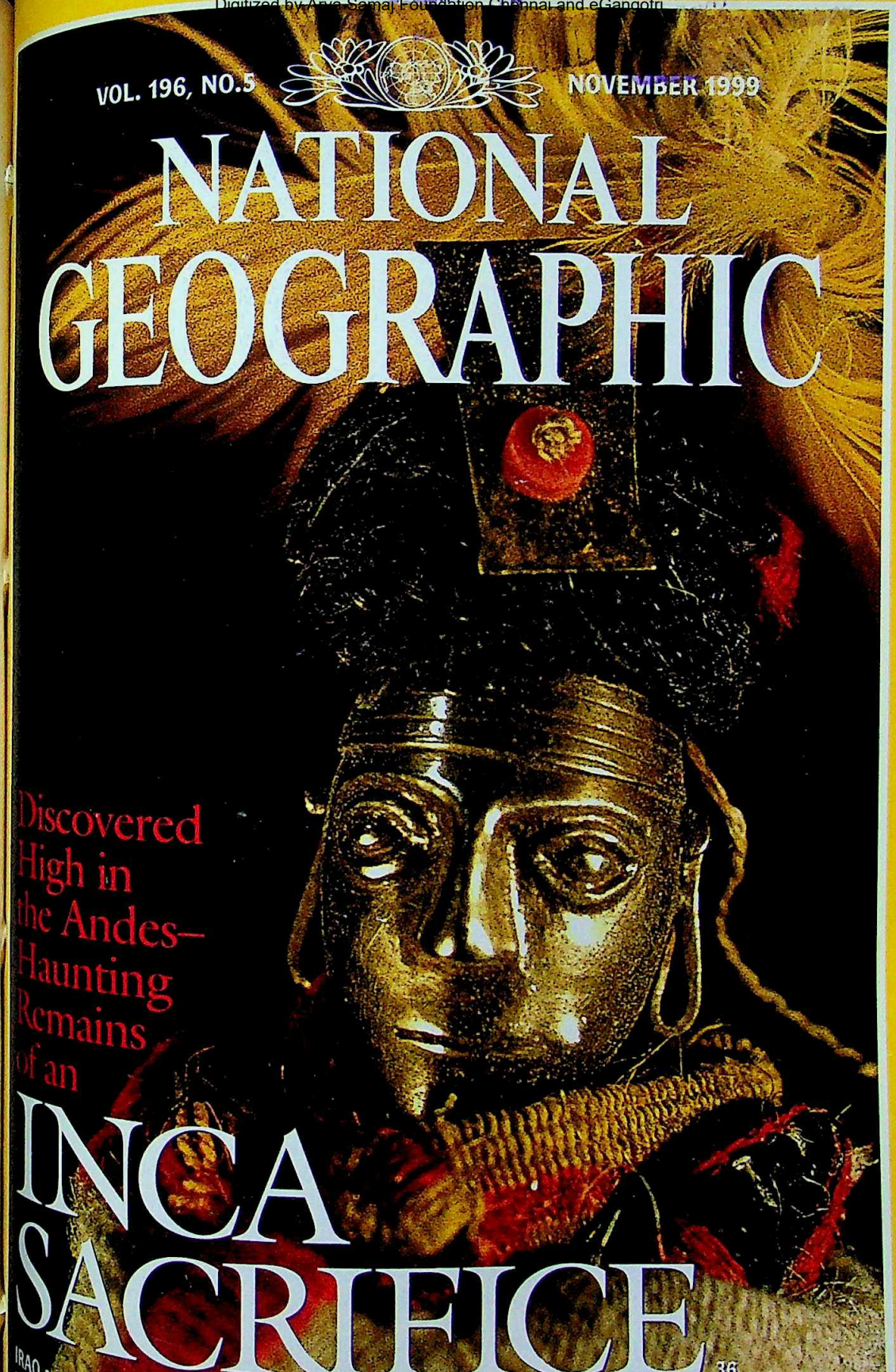

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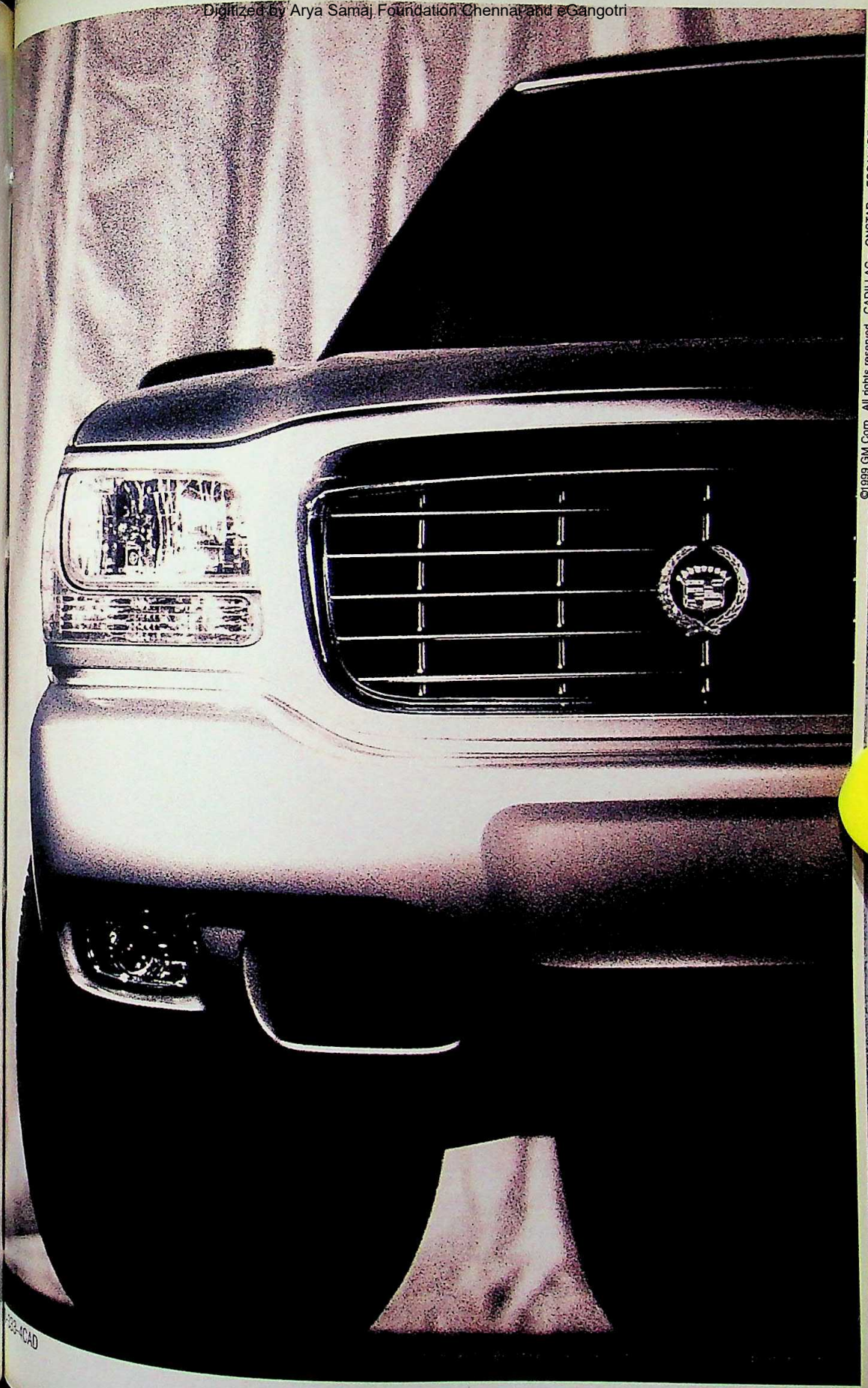

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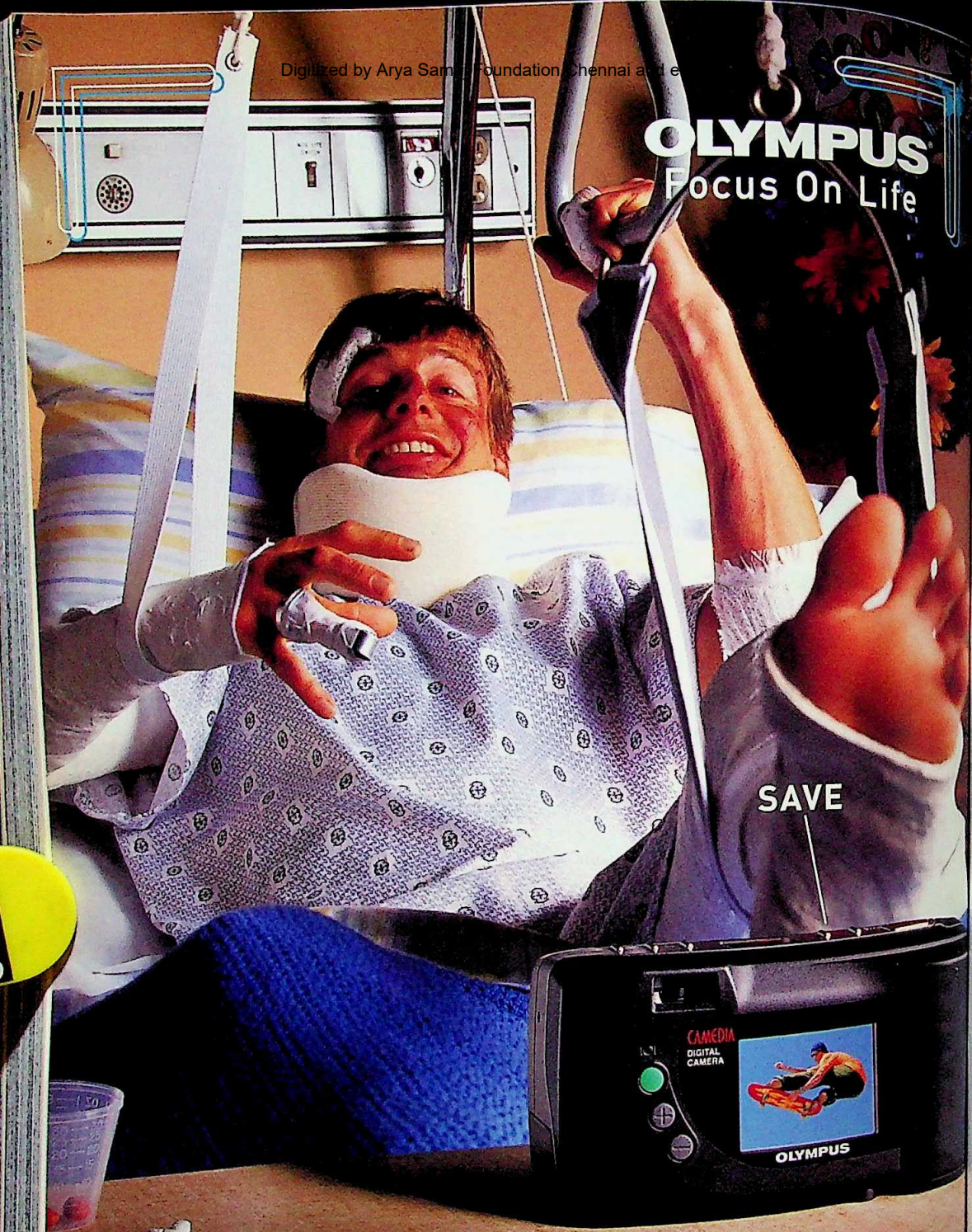

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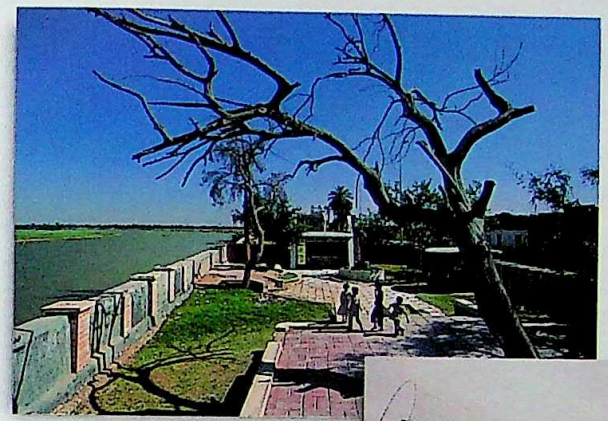
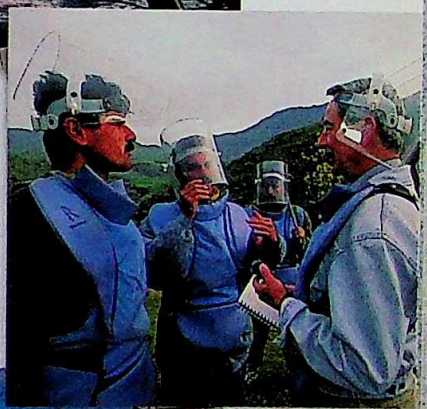
NATIONAL GEOGRAPHIC

From the Editor

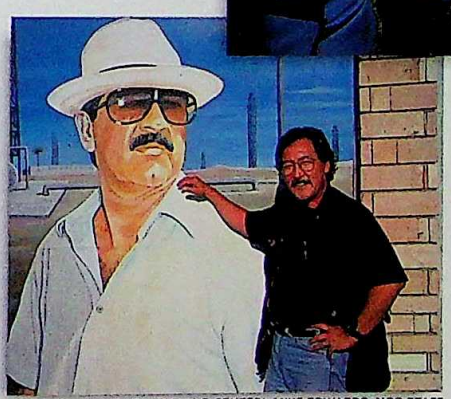


IT'S NOT MUCH to look at now, perhaps, but you should have seen it in the early days—the *really* early days when, according to tradition, this spot at the confluence of the Tigris and Euphrates Rivers in Iraq was the site of the biblical Garden of Eden.

For Assistant Editor Mike Edwards and photographer Michael Yamashita the opportunity for a rare in-depth look at Iraq came out of nowhere. The pair are working on an article about Marco Polo, who wrote about Iraq, and what was supposed to be a short visit became, at the permission of the government, a six-week excursion.



"I don't mean to say we were given carte blanche," says Edwards. "We were closely monitored by two minders. But we did, I believe, come back with a fair story. Certainly Iraq wanted to use us to help get the United Nations embargo lifted, but we also found that a large slice of people—Shiites especially, as well as the Kurds—oppose Saddam Hussein's regime."



MICHAEL YAMASHITA (TOP AND CENTER); MIKE EDWARDS, NGS STAFF

Edwards spent some nervous hours in northern Iraq with a newly trained team of Kurdish sappers (center), who scour the countryside for land mines. And Yamashita, searching out the variety of Saddam images plastered throughout Iraq, found one that resembled a vacation snapshot from Miami Beach.

Now it's back to their epic journey in the great traveler's footsteps. "It's been 700 years since Marco Polo's odyssey," says Edwards. "What's another year or so?"

Bill Allen

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Eyewitness

IRAQ

By MIKE EDWARDS ASSISTANT EDITOR

Photographs by MICHAEL YAMASHITA

PUTTING ON A LOYAL FACE, local militia march in Saddam Hussein's hometown, Tikrit, on the Iraqi ruler's 62nd birthday. Saddam was a no-show, perhaps unsure of his safety in a land torn by ethnic divisions and crippled by war and UN sanctions.

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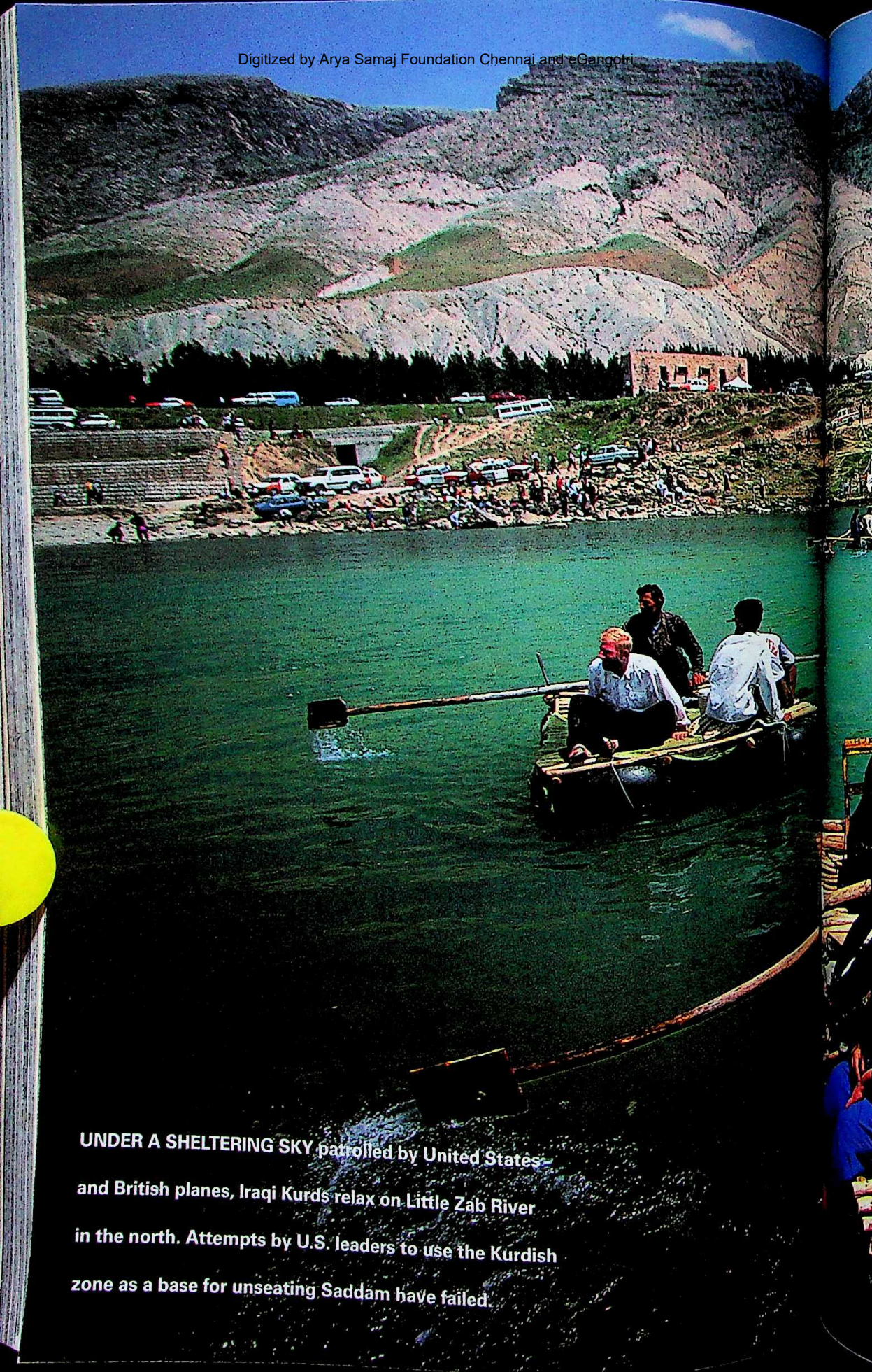

UNDER A SHELTERING SKY patrolled by United States and British planes, Iraqi Kurds relax on Little Zab River in the north. Attempts by U.S. leaders to use the Kurdish zone as a base for unseating Saddam have failed.

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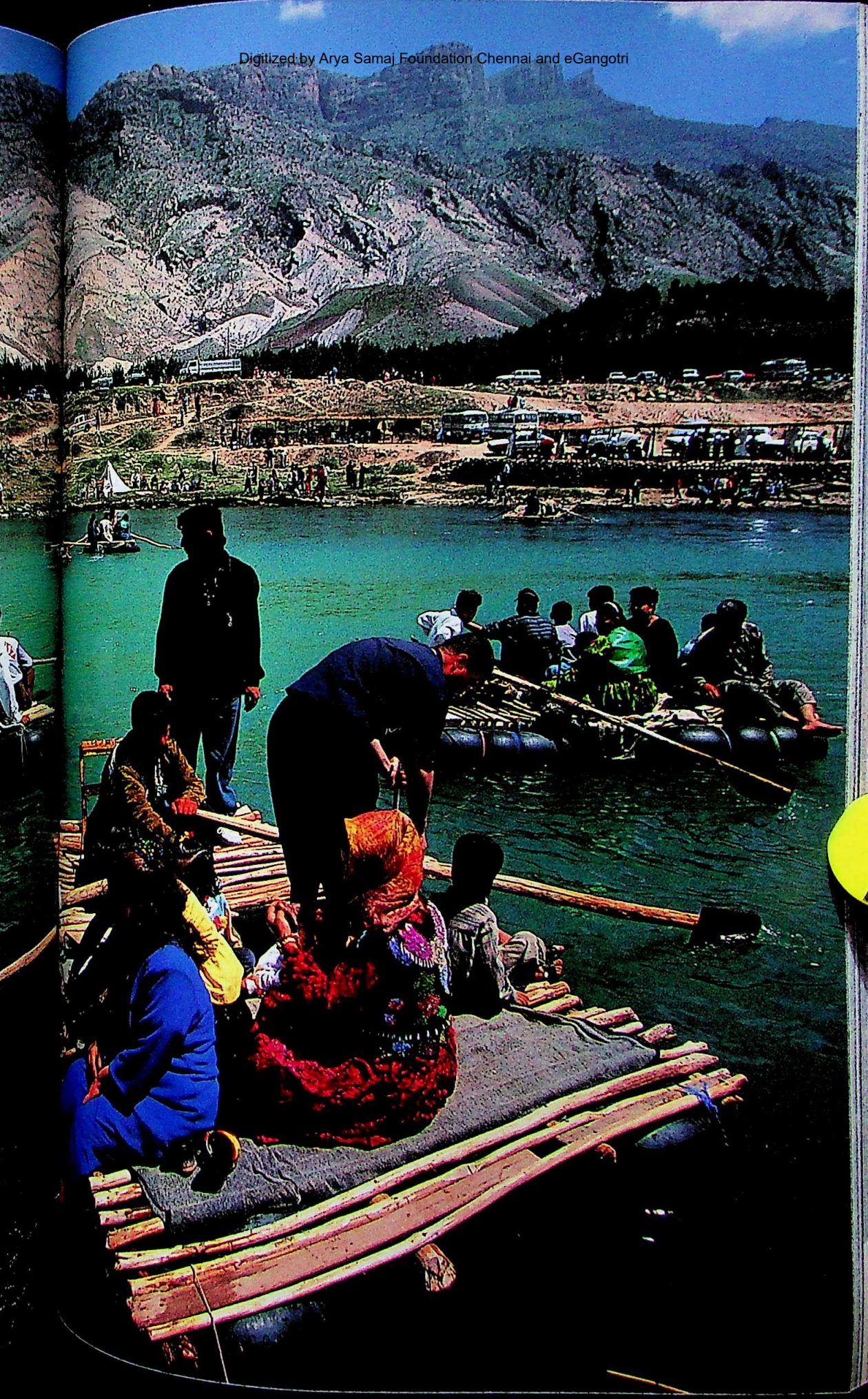
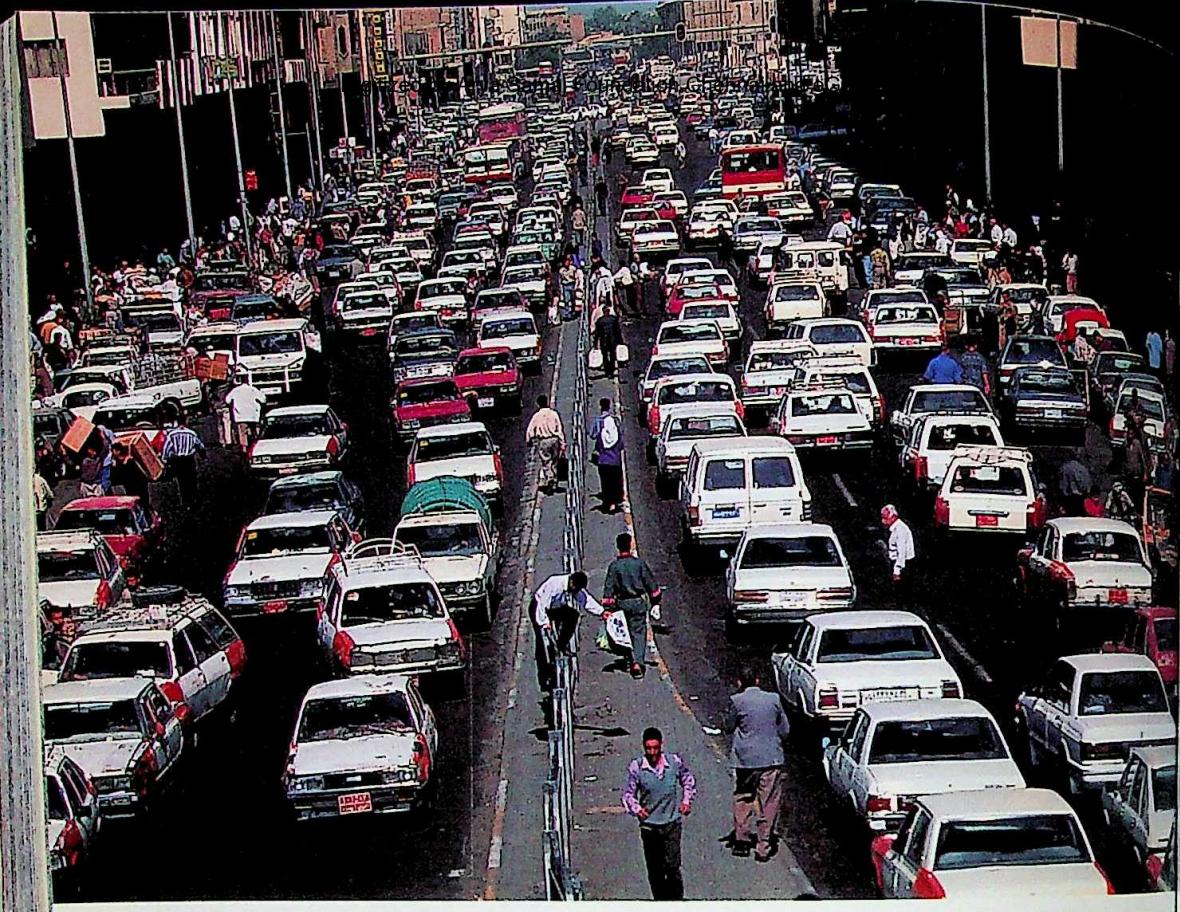


VISIONS OF PAST EMPIRES entertain members of Baghdad's upper crust at a Fashion Institute costume show. Although general living standards have crashed, a ruling class thrives, largely on embargo-defying trade.



The world's cheapest gas, at ten cents a gallon, keeps traffic limping along in central Baghdad. With hyperinflation shrinking most professional salaries to less than ten dollars a month, driving a battered red-and-white taxi has become a career move for teachers, engineers, and lawyers.

THE DIRECTOR general of antiquities apologized for yawning. It was 1:30 p.m. in his office near the Iraq Museum in Baghdad. "I got up at three this morning," Muayad Said Damerji explained. "That's when the electricity came on in my neighborhood."

Bombed in the 1991 Persian Gulf war, Iraq's power plants still wheeze along at half their former capacity. So for six hours every day, every Baghdad neighborhood takes a turn without electricity.

"This is a quiet time in archaeology," Damerji said. "We get to do our own projects now." He rose early to write a little more of what surely will be a massive text, the history of architecture in Mesopotamia, the land between the Tigris and Euphrates Rivers, where Western civilization took root.

United Nations sanctions, which include a trade embargo in effect since Iraq's invasion of Kuwait in 1990, keep away the foreign teams—American, German, Italian, French, Japanese—that used to stream into his office to propose excavations in Iraq's fabulous ruins. It is still possible to ascend the ziggurat of Ur and puzzle over the cuneiform scribed there or to stroll in Babylon and imagine the splendor of the hanging gardens. I did those things, but I was all but alone, for tourism is dead, dead.

And to enter the Iraq Museum is like entering a succession of looted tombs. In those halls had been gathered treasures from all the epochs of Iraq; an entire room was devoted to gold ornaments from the eighth-century B.C. Assyrian capital, Nimrud. The display cases are empty now; all the objects that could be moved have been packed and stored.

It is a melancholy refrain, the closing of the museum. The display cases were emptied twice in the 1980s, when bombs and Scud missiles

---

Photographer MICHAEL YAMASHITA, a GEOGRAPHIC contributor for 20 years, worked with MIKE EDWARDS to cover China's Gold Coast and Hong Kong (March 1997) and explorer Joseph Rock (January 1997).

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rained on Baghdad during the eight years war with Iran. In the gulf war, bombs exploded only 20 yards from the museum. "Face-to-face!" exclaimed curator Nedhal Ameen. The apparent target was a telephone center a block away. Vibrations shattered glass. Two Babylonian figures toppled. "What can we do with America?" Nedhal sighed. Then, brightening: "You come again someday; maybe you can see everything, *Inshallah.*"

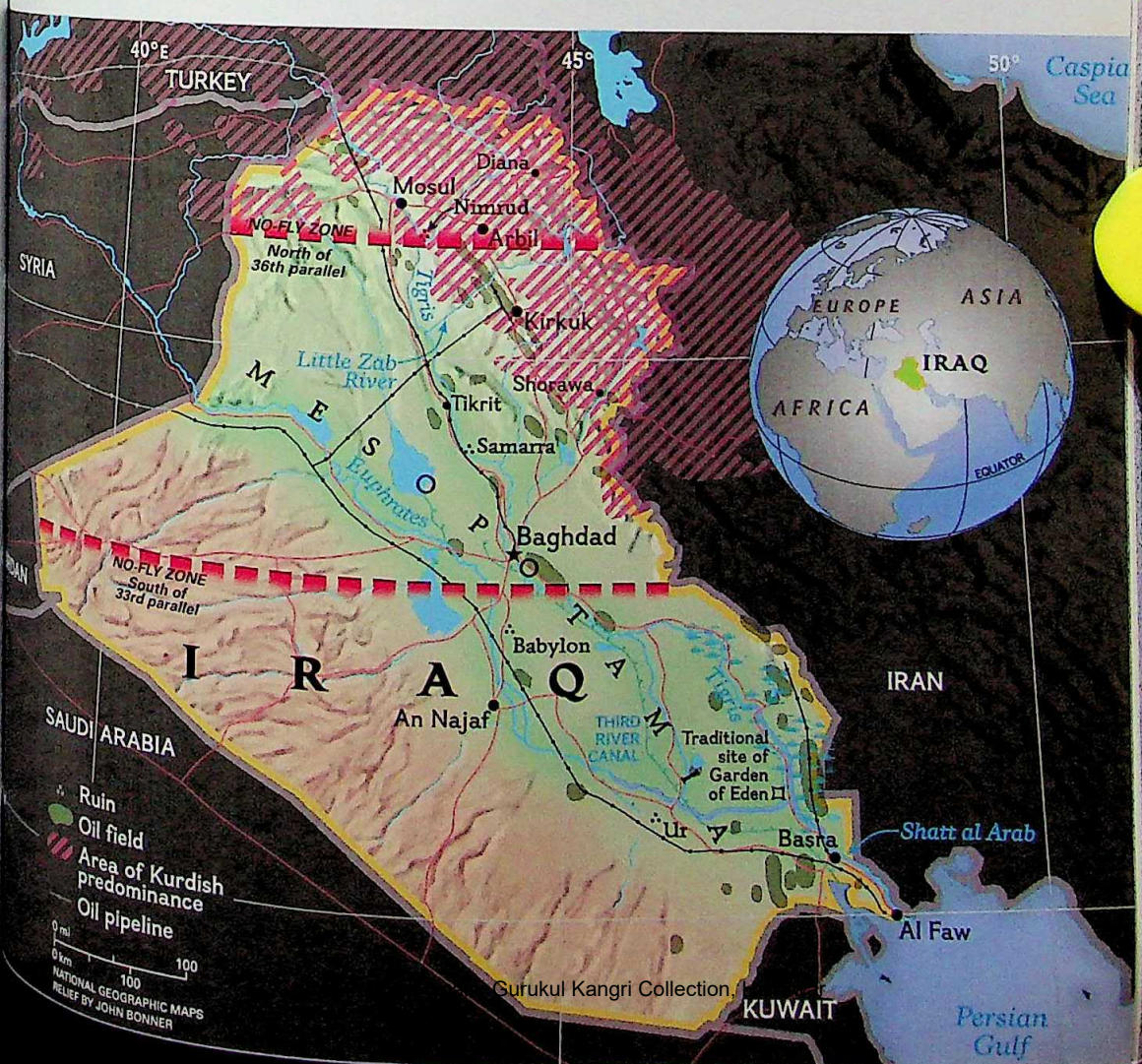
All Mesopotamian empires endured paroxysms of war and destruction; the gulf war is one more chapter. With photographer Michael Yamashita, I spent almost six weeks gauging the echoes of that war. We found southern Iraq bristling with the guns of President Saddam Hussein's army. The people, mostly followers of Islam's Shiite branch, rose in 1991 against Saddam, long their oppressor. Shiite guerrillas still mount raids against his troops.

We saw plenty of guns in the north too, but they were in the hands of some three million Kurds, the largest minority in this mainly Arab nation. In their off-and-on war with the Iraqi Army the Kurds also suffered terribly; Saddam even used poison gas, killing 5,000 Kurds in a single town. But in 1991, threatened by a new Kurdish revolt, the army retreated from the mountains of the Kurdish homeland, and today the Kurds run their own affairs.

Both the Shiites and the Kurds receive a modest measure of protection from U.S. and British warplanes patrolling no-fly zones to keep Iraqi aircraft from flying there. Iraqi gunners sometimes fire at the planes or track them with radar. The planes retaliate against military targets, though straying missiles have hit civilian neighborhoods.

That has happened, for example, in the city of Mosul, within the northern no-fly zone. One day there I asked a priest—720,000 Christians live in Iraq—if air-raid sirens made

Saddam Hussein's repulsed invasion of Kuwait in 1990 and his refusal to dismantle weapons of mass destruction have reduced a respected nation, rich in oil, to a pauper state flanked by rivals—Turkey and Iran. Observers say that trade sanctions may have cut Iraq's revenues by 90 percent.



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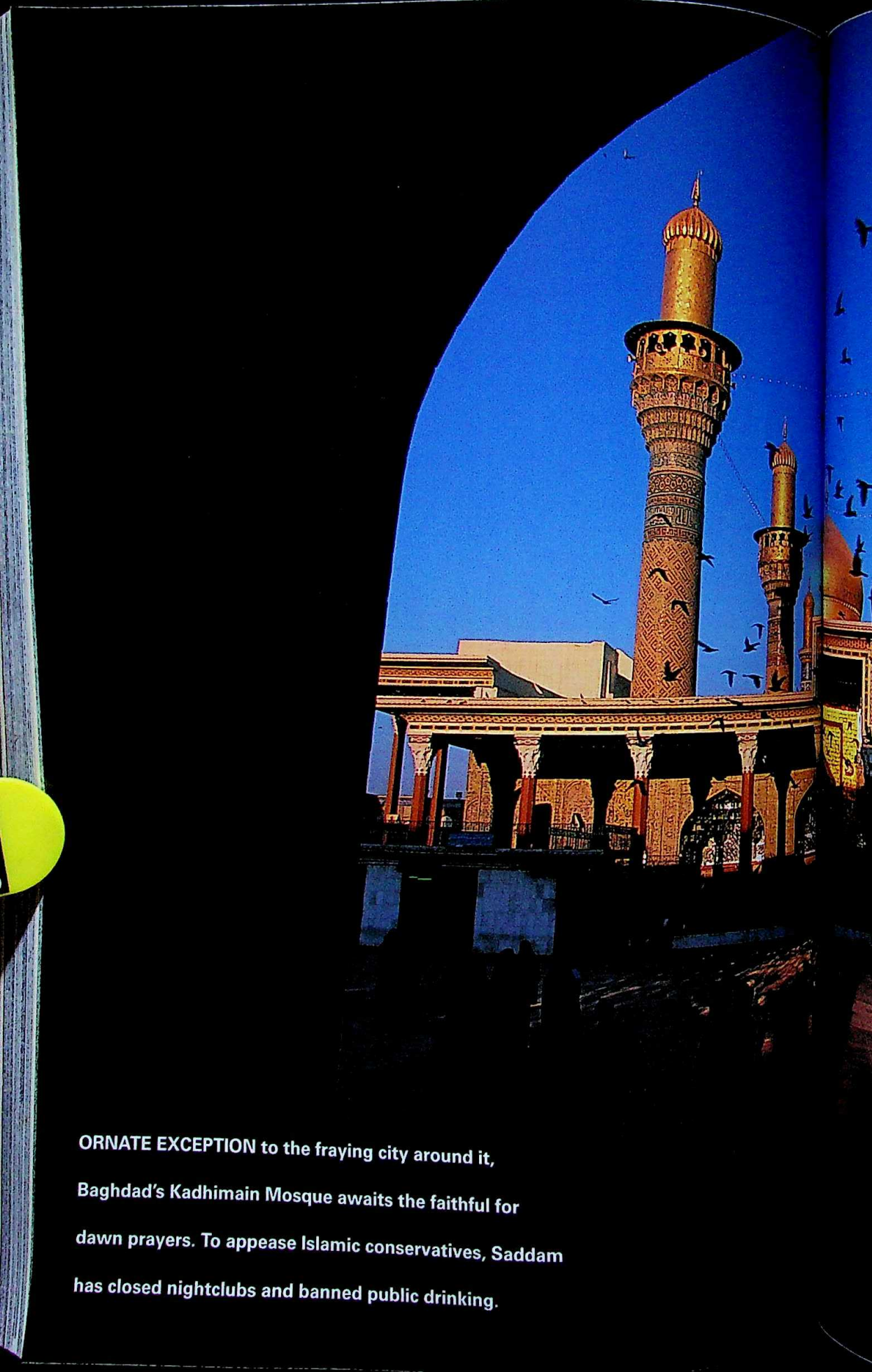

ORNATE EXCEPTION to the fraying city around it, Baghdad's Kadhimain Mosque awaits the faithful for dawn prayers. To appease Islamic conservatives, Saddam has closed nightclubs and banned public drinking.

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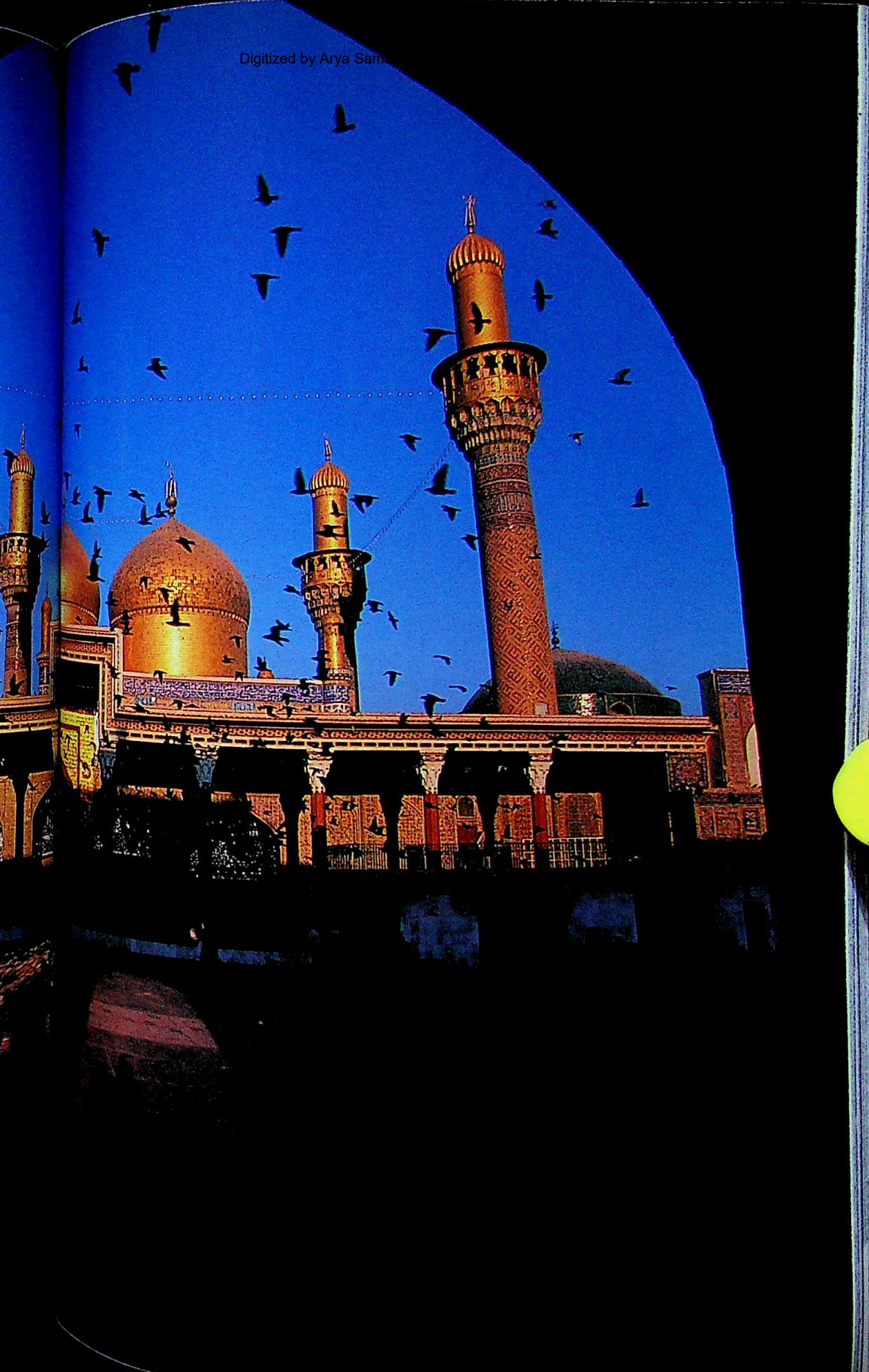

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people afraid. His answer described a main body of the populace: "They have lived with war for so many years they don't care. Nearly every family has lost someone. Life is very cheap here." In the Iranian war an estimated 500,000 Iraqi soldiers were killed or wounded; Operation Desert Storm inflicted between 60,000 and 100,000 casualties more.

When Mike and I set out, we expected to spend only a couple of weeks in Iraq. We were following the route of Marco Polo, who may have passed through the area in 1271 on his way to China. Perhaps the Iraqi government allowed us to stay longer in hope that we'd report extensively on the suffering of Iraqis under the UN sanctions. Since no airline flies into Iraq—another manifestation of the sanctions—we set off from Amman, capital of Jordan, in a hired van. Ten hours later, beside the Euphrates, the bare desert gave way to palm groves, and in another hour we were among Baghdad's modern, sand-colored buildings.

War, what war? I asked myself at first. Although Baghdad was bombed in 1991 and again in December 1998, most of the debris has been cleared. Rebuilt bridges span the Tigris.

In place of a toppled communications tower the government raised a spire with a revolving restaurant. As I dined there one night, about 125 yards up, Baghdad—home of five million people—spread out as a great disk. The slowly turning windows brought into view the stylish apartment and office buildings that oil paid for in the 1970s and 1980s, then rows of large homes bathed by street lamps. Next came a swath of darkness—a neighborhood whose turn had come to do without electricity. (Imagine your air conditioner shutting off in summer when the temperature is 120°F.)

The restaurant moved, and I beheld an enormous domed edifice, brilliantly lit, surrounded by a high wall. This is one of Saddam's new palaces; by some counts he has more than a hundred palaces and mansions. Iraqis say Saddam and his family occupy only a few; evidently the others exist to gratify his ego.

I wasn't the first journalist to ask Mohammed Fatnan, my government guide—known in the trade as a "minder"—about these Arabian Nights creations. Touchy subject. "Why do the Western media make propaganda about the palaces?" he shot back. "The royal family of Saudi Arabia has palaces. Why don't the Western media write about them?"

Mohammed's main job was to keep an eye on me and tell me what I could and couldn't do (no interviewing soldiers, for instance). He was 32, with a short beard. His salary was about 10,000 dinars a month—handsome pay before Iraq's economy sank under the weight of the embargo and two costly wars. Now a single dollar buys 1,200 dinars. So he lived in the Ministry of Culture and Information press center, sleeping on a couch. Yet if Saddam's palace profligacy angered him, he never showed it.

MOST IRAQIS were civil, some telegraphing friendship by such comments as, "I loved President Kennedy." Or, "How can I get to America?" I even heard Saddam (he's usually called by his first name) labeled "a butcher." Such things were said when I was alone with someone; no Iraqi wants trouble with the omnipresent secret police, who have been known to torture and kill citizens. Others condemned Saddam for his wars. A young man with limited English said with eloquent pith: "He need all time more war, Saddam. He like war."

That's not the view of Abdul Razzaq Abdul Wahid. A poet, he's a member of the establishment, which includes Saddam's kin, military officers, officials of the ruling Baath (Renaissance) Party, and several loyal Arab clans. "You Americans have a black idea about this man," Abdul Razzaq declared when I visited his comfortable home. "He's very gentle, very kind." And very strong. "Sometimes when he looks at me, I want to put my hands over my head because I think a knife is coming, like he's going to cut off my head."

At a Saddam birthday celebration last April 28, Abdul Razzaq delivered a glowing tribute. Saddam, who turned 62, was absent; presumably fearing assassination, he rarely appears in public. No matter; the party went on, and the Baath faithful enjoyed the huge cake.

For years Saddam has rewarded his favorites with presents of automobiles and cash (when the dinar was valuable). "I'm not rich," Abdul Razzaq said, "but I can live good."

Inflation and shortages compel other Iraqis to recycle almost everything. Among the carcasses at the Abu Mahmud Garage were two 1960s-vintage Volkswagens that looked to have fried in the desert for years. But they would

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Prayer softens hard times for a family visited in a Baghdad poorhouse by Sister Olga Noel Yaquob, a Christian charity worker. Where once obesity was a national health concern, most Iraqis now survive on meager government rations. Malnutrition and disease have led to a rising death rate among children.

be on the road as soon as the Abu Mahmud salvagers had patched the floors, rebuilt the engines, sewed up the seats, and found tires Allah knows where.

"Rubbish!" exclaimed a businessman who was waiting for his own car to be repaired. "This is rubbish work! It's not for Iraqis. It's for the poorest country in the world. We used to bring in Egyptians to do jobs like this." Or, more likely, old cars were abandoned, for Iraq was a throwaway society, thanks to oil.

Cars and parts are banned under the embargo. Yet the traffic of Baghdad, this Bondo city on the Tigris, sometimes included a sporty new BMW or a regal Mercedes. "The embargo hurts just the good people," an Iraqi said. "The bad people get whatever they want."

There's no shortage of gasoline, and at ten cents a gallon it's the world's cheapest. Most of Baghdad's fuel comes from the Daura Refinery at the city's edge. Heavily bombed in 1991, it's an example of recycling on a grand scale. "I didn't have dollars to buy parts, and if I had dollars, nobody would have sold me parts because of the embargo," said Dakhar Y. Al-Khashab, the maintenance chief. "So we had to make thousands of things. That was new for us. The old way, if we needed a pump shaft, we just got it from the warehouse." He added exultantly, "The more time we spend under sanctions, the more things we produce."

People have been recycled as well: engineers into mechanics, professors into taxi drivers. The driver I got from the Al-Rashid Hotel, Samil Mahsud, owned a dressmaking business before the economy collapsed. "It was very profitable," he said. "Iraqi women spent half their money on fashion." Now he earns six dollars a day, when there's work.

Wassan Khalid Al-Ameed, a civil engineer, became a broker. I watched her dash across the floor of the Baghdad stock exchange to consult her clients. Then she elbowed into a crowd of brokers to offer a thousand shares of Baghdad Soft Drink. Iraq's biggest soda bottler was a hot

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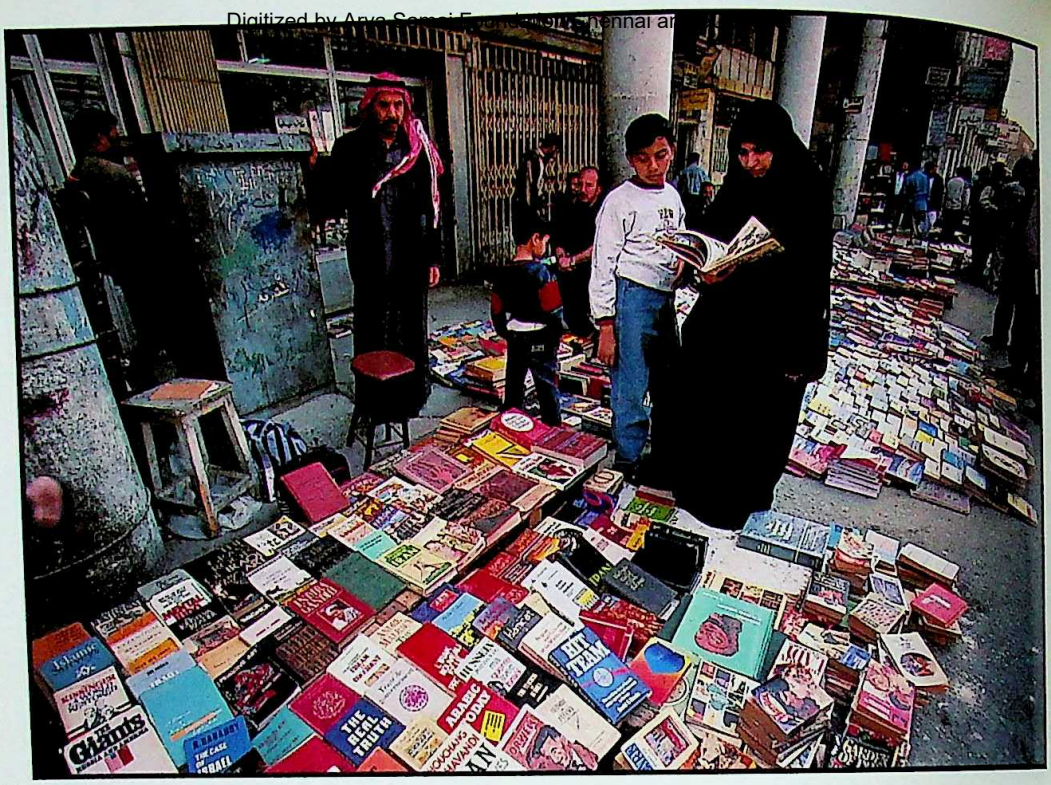
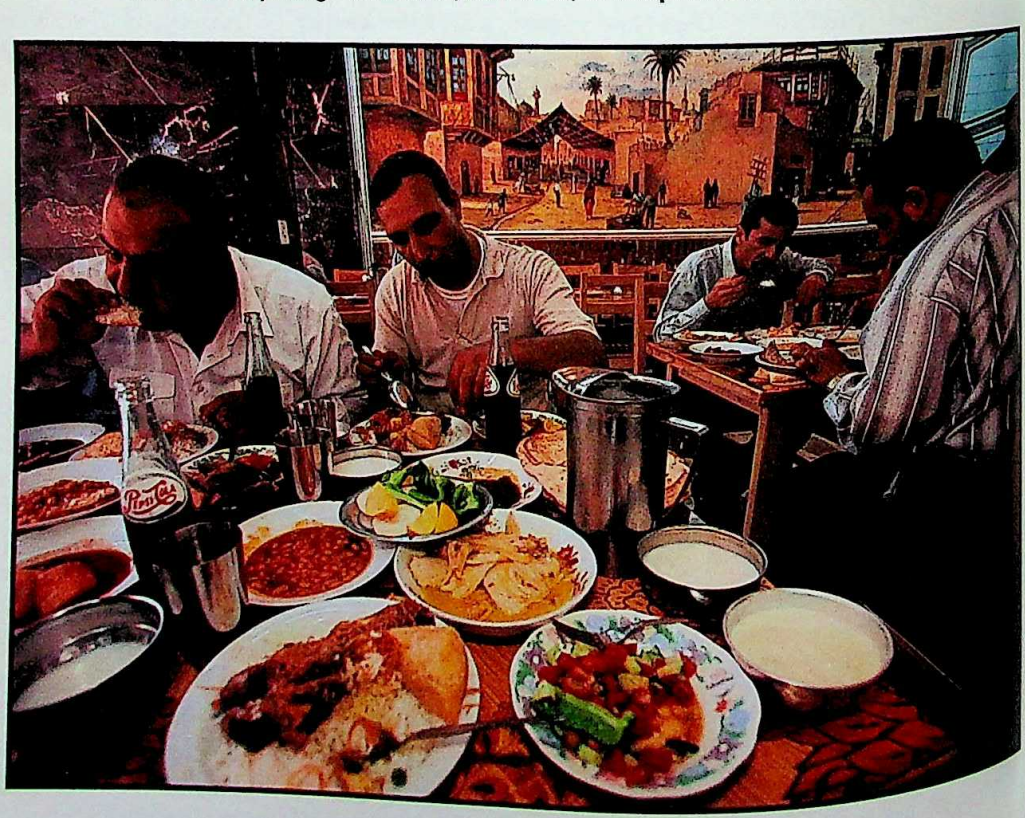


Supply overwhelms demand on a Baghdad street (above); many books are in English, once taught in schools. Middle-class Iraqis flood markets with household goods to earn cash, sometimes for exit visas. Despite the trade embargo, almost everything—medicine, new cars, an ample meal—is available for a price.



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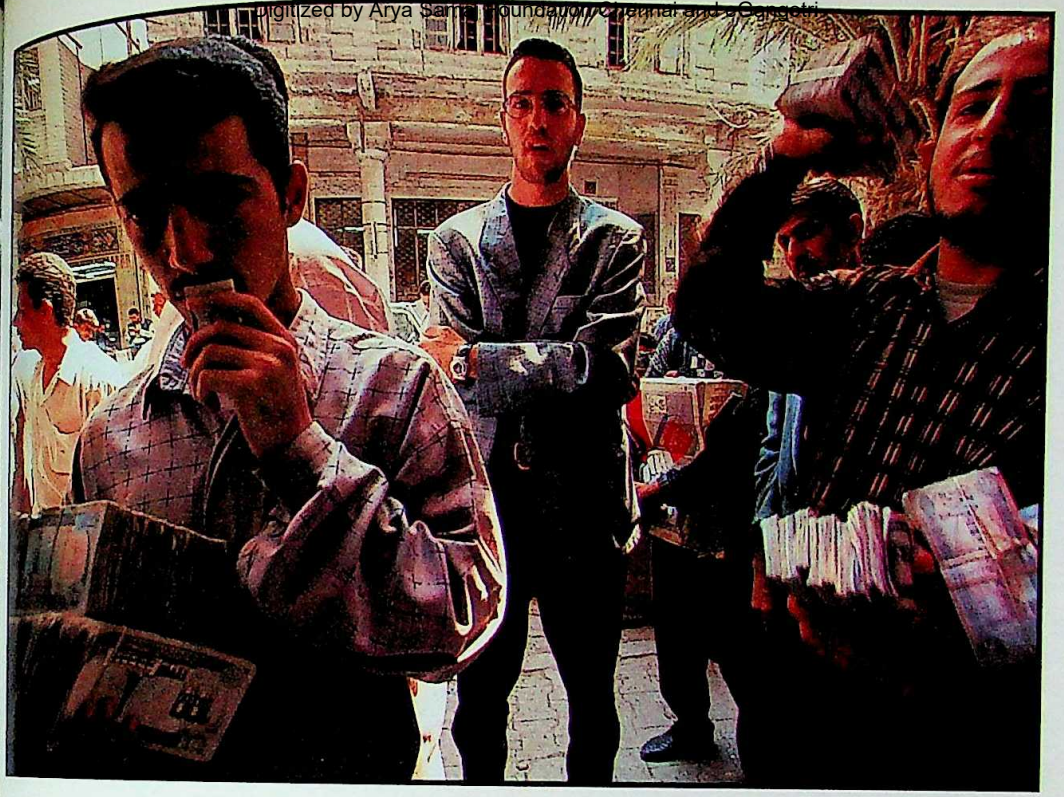
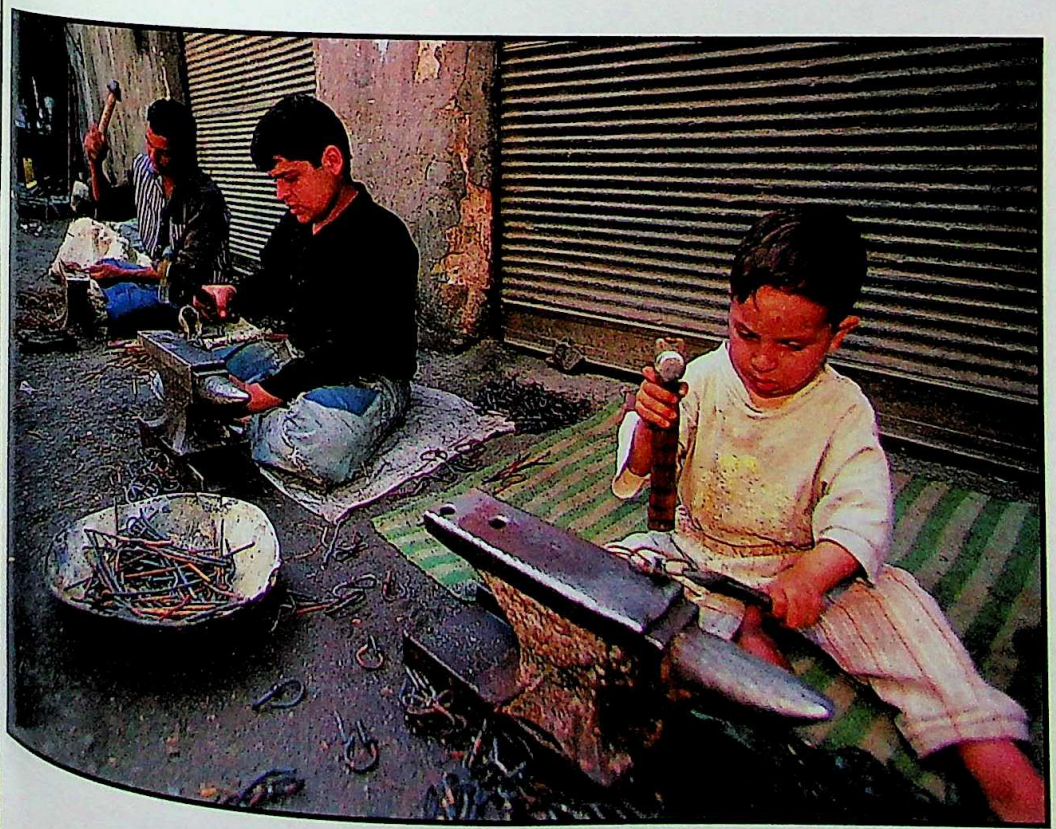


Weighed down with dinars, money changers (above) stalk a Baghdad street where foreign journalists, merchants, and United Nations officials pass by with their hard currencies. Desperate for money, a father turns to his sons, even a four-year-old, to hammer out chain links. People who beg risk jail.



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number among the 96 stocks. It was selling at 87 dinars a share, about 7.3 cents. For investors, a good day at the exchange nets $33.

Iraqi women are among Islam's most liberated. Still, Wassan said, "There is a lot of resentment. Some men think this is not a job for women. But I like making my own way. I did about 10 million dinars [$8,300] in business today." And in three years she had saved 15 million dinars of her own. In depressed Baghdad, that will buy a house.

Sometimes Mohammed, Samil, and I ate lunch at Candles, a restaurant surviving amid the grimy windows of long-closed airline offices. Lunch is Iraq's main meal, so we gorged—skewered lamb or chicken, rice, eggplant, tomatoes, hummus, baba ghanouj, olives, disks of bread, tea. Cost for the three of us: six dollars.

As we left, we would be accosted by a wisp of a girl. Only six, Sara was the youngest of four children living with a widowed mother. "We never used to have that," Samil said of child beggars. He began to take some of his own lunch to her, and I contributed wads of dinars.

Though money is scarce, no one should be starving, even though Iraq in normal times produced only 30 percent of its food. Sara's family receives flour, rice, tea, sugar, cooking oil, even soap. These began to be imported in 1997 under the UN's "oil-for-food" program. To relieve suffering, the UN Security Council eased the sanctions, permitting Iraq to sell oil to get money for food, medicine, school supplies, farm equipment, and spare parts for essential industries. Iraq decides what to buy, but the UN keeps the checkbook and must approve all purchases. At present Iraq can sell 5.2 billion dollars' worth of oil in a six-month period. Some money goes to persons who suffered losses in Kuwait; two-thirds is reserved for humanitarian goods.

The oil-for-food program has boosted rations from 1,300 to 2,000 calories a day; that's close to the average intake of many Western nations. Nevertheless, says the UN, perhaps 20 percent of Iraqi children are malnourished, missing protein, vitamins, and minerals.

Journalists are often taken to the 320-bed Saddam Children's Hospital—one of numerous institutions bearing the president's name—to hear reports such as Dr. Mazin Shimar offered. "In this hospital we have two or three deaths a day," he said. "It used to be one a week." The Ministry of Health claims that more than a million children under five have died as a result of the embargo.

View from a minaret reveals the dense, stone-colored hive of the old quarter of Mosul, Iraq's front-line city in the conflict against the Kurds and their Western protectors. Air-raid sirens and antiaircraft fire regularly echo through the narrow streets as U.S. and British planes sweep close, patrolling the northern no-fly zone to prevent Iraqi aerial incursions.

Such figures have helped win support in the U.S. for Iraq's campaign to end sanctions. "The death and suffering . . . seems to us morally intolerable," the United States Catholic Conference has declared. Antiwar activists have condemned the sanctions as "genocidal."

"I'm sure that Saddam Hussein decided 'we have to show a lot of deaths,'" says Richard Garfield, a public health specialist at Columbia University in New York. "It happened that they had a lot of deaths. But their information was so poor they didn't really know how many." Using demographic and other studies, Garfield has estimated the number of excess deaths of children under five from the start of sanctions

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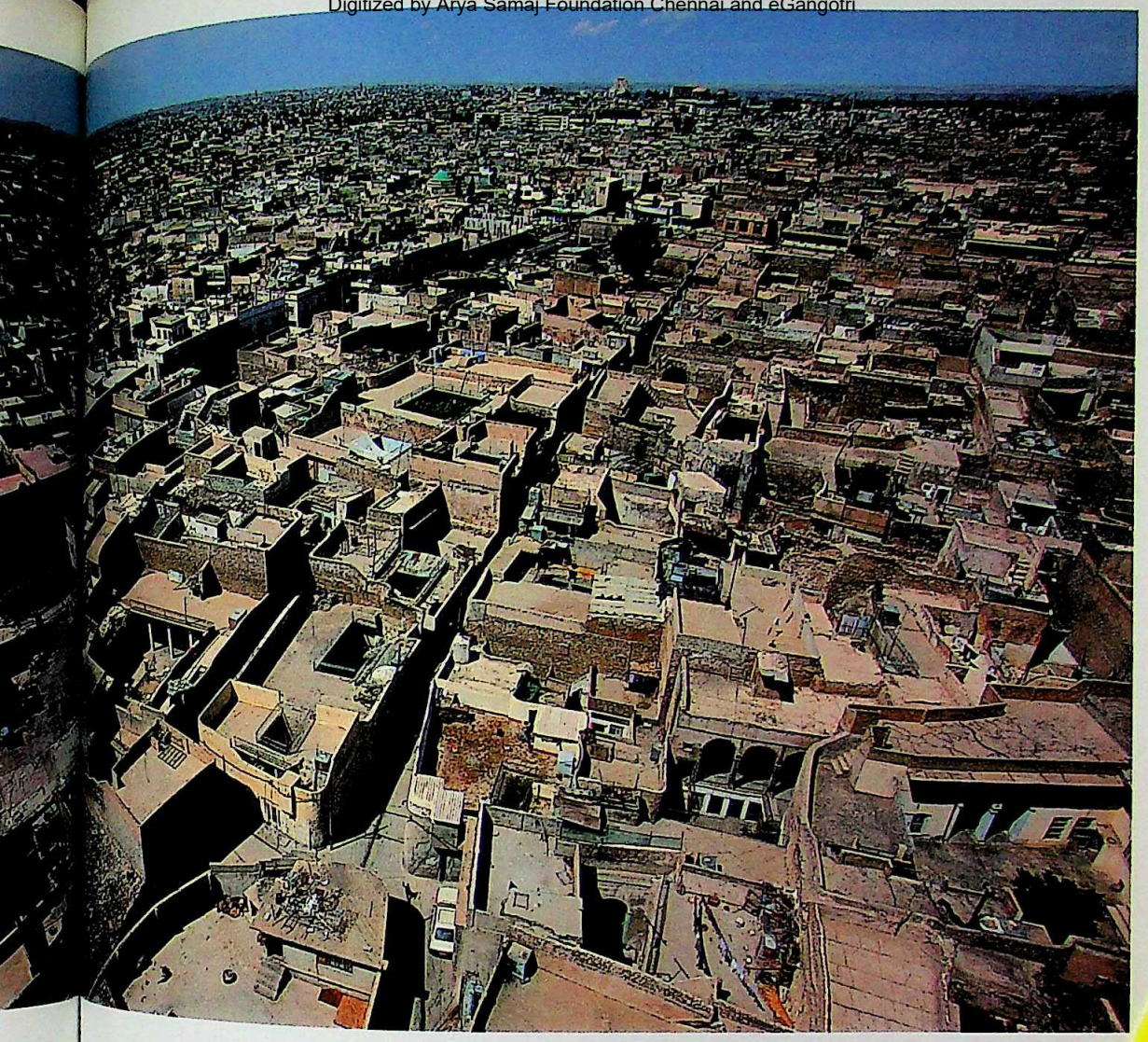

in 1990 until March 1998. His most likely figure: about 227,000. He believes the number of deaths per thousand children more than doubled from 38 in 1990 to 87 in 1998. "It is a remarkable statement of how bad conditions are," he said. A UN survey puts the number of deaths even higher, 131 per thousand, during the past five years. The causes of death include malnutrition, a decline in immunizations, and polluted water. Water systems are in bad shape; mains leak, pumps don't work. And both water and sewage systems are handicapped by the power outages.

Many observers put some of the blame for deaths on Saddam. He delayed more than a year before agreeing to the oil-for-food program proffered by the UN. His government paid scant attention to repairing water systems; most of the new pumps ordered under the program were sitting in government warehouses during my visit. More than 275 million dollars' worth of medical equipment had gathered dust for months. Some highly placed UN diplomats suspect that Saddam was more interested in making propaganda about the deaths than in breaking bottlenecks.

Sanctions were conceived as a means of forcing Saddam to give up the weapons of mass destruction—chemical, biological, nuclear—that he was believed to possess or to be making. U.S. officials say Saddam intended to use such weaponry to dominate his oil-rich neighbors around the Persian Gulf. But after the 1998 bombing of Iraq, Saddam refused to let the UN weapons inspectors into the country. So, for now, the sanctions saga has no end.

All the same, the U.S. is convinced that the embargo applies pressure on Saddam. And besides, a State Department official says, "If he were handling his money instead of the

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ACCESSORIZED WITH A KALASHNIKOV, a Kurdish wedding guest intends to protect family and friends if a feud erupts between attending clans. Peace prevailed, grounds for celebrating with a few rounds from her noisemaker.

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UN, he'd go right back to making weapons.

To a 25-year-old woman named Rana, whom I met one day in Baghdad, sanctions were just one more source of grief. "We are a broken generation," she said. "My generation opened our eyes on war, the war with Iran. We all saw men coming home without an arm or a leg. We have only small dreams, and we are losing even those. Why does the embargo have to continue? Haven't we suffered enough?"

Another question might be: Haven't we had enough of propaganda? It's a major industry. Take, for example, the Mother of All Battles, as Saddam called the fight against Operation Desert Storm in 1991. Who won? A new statue of Saddam—there are at least three recent ones in Baghdad—answers the question. He stands in an army uniform over the flattened faces of the gulf war leaders arrayed against him: President George Bush, Britain's Margaret Thatcher, France's François Mitterrand, Kuwait's Sheikh Jabir, and King Fahd of Saudi Arabia. The message of these puny pancakes: I trampled you.

"A big battle was fought between Iraqi tanks and American tanks, and Iraq won," a man of about 50 assured me. He may have believed Iraq won. Or maybe he *wanted* to believe, for Iraqis are a proud people. In any case, the news as presented by Iraqi television didn't acknowledge the huge number of casualties or the loss of 2,100 tanks. And no foreign television reports reached Baghdad; owning a satellite dish is forbidden.

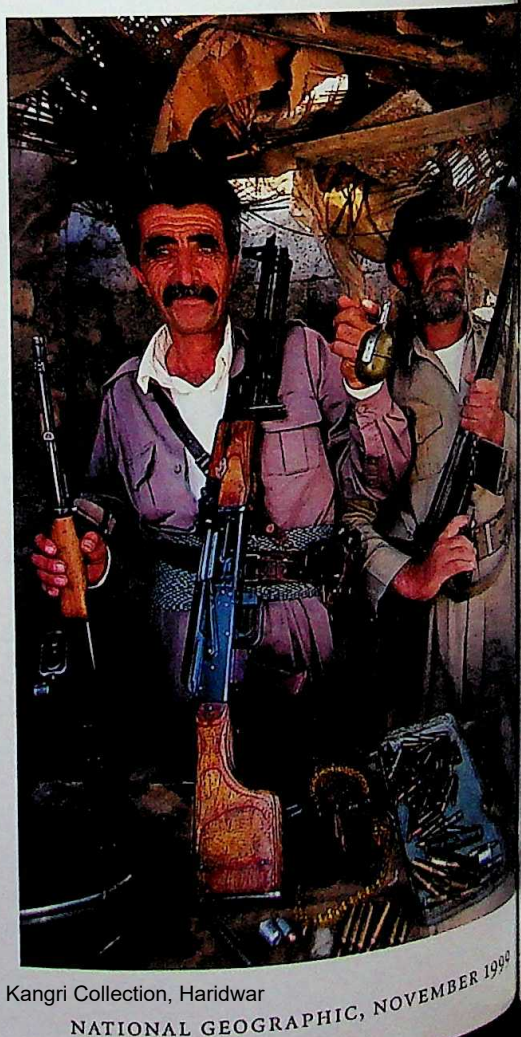
FIGHTING has never entirely stopped in southern Iraq. Desert and marsh, with a scattering of modest cities, it is the stronghold of the Shiites, who rose against Saddam as the gulf war ended. Helicopters and tanks quelled that revolt, but guerrillas still appear at night to attack an army outpost or a Baath Party headquarters. Dissidents living outside the country, who receive smuggled reports, say troops have machine-gunned demonstrators in cities and used artillery against villages.

The Shiites are a majority chafing under minority rule. Among Iraqi Arabs, they outnumber Sunni Muslims about two to one. But Sunnis dominate in Saddam's regime and the Baath Party. The Baathists began in the 1970s to curb the influence of Shiite clerics, executing several. Seminaries were closed, religious publications censored. Retaliating, militant Shiites have twice tried to assassinate Saddam.

I asked the Ministry of Information several times to let me go south, and at last permission came. On the surface all seemed peaceful as Mohammed and I headed toward the old port of Basra, 350 miles southeast of Baghdad. Most of the way the road followed the Tigris. Irrigation canals laced the sand, nourishing wheat fields and plots of onions. Shepherds guided their flocks to grass. War, what war?

But the farther south we went, the more often we encountered the army. Small fortresses appeared in the desert every couple of miles. Automatic weapons were trained on the road from sandbagged sentry stations. Expatriate Iraqis say guerrillas are most active in Iraq's southeastern corner, near the Iranian border. Iran's Shiite government succors some of these "national resistance fighters."

Amid this cauldron of trouble is located, according to Iraqi lore, the Garden of Eden. I wanted to see it, but we needed an escort to



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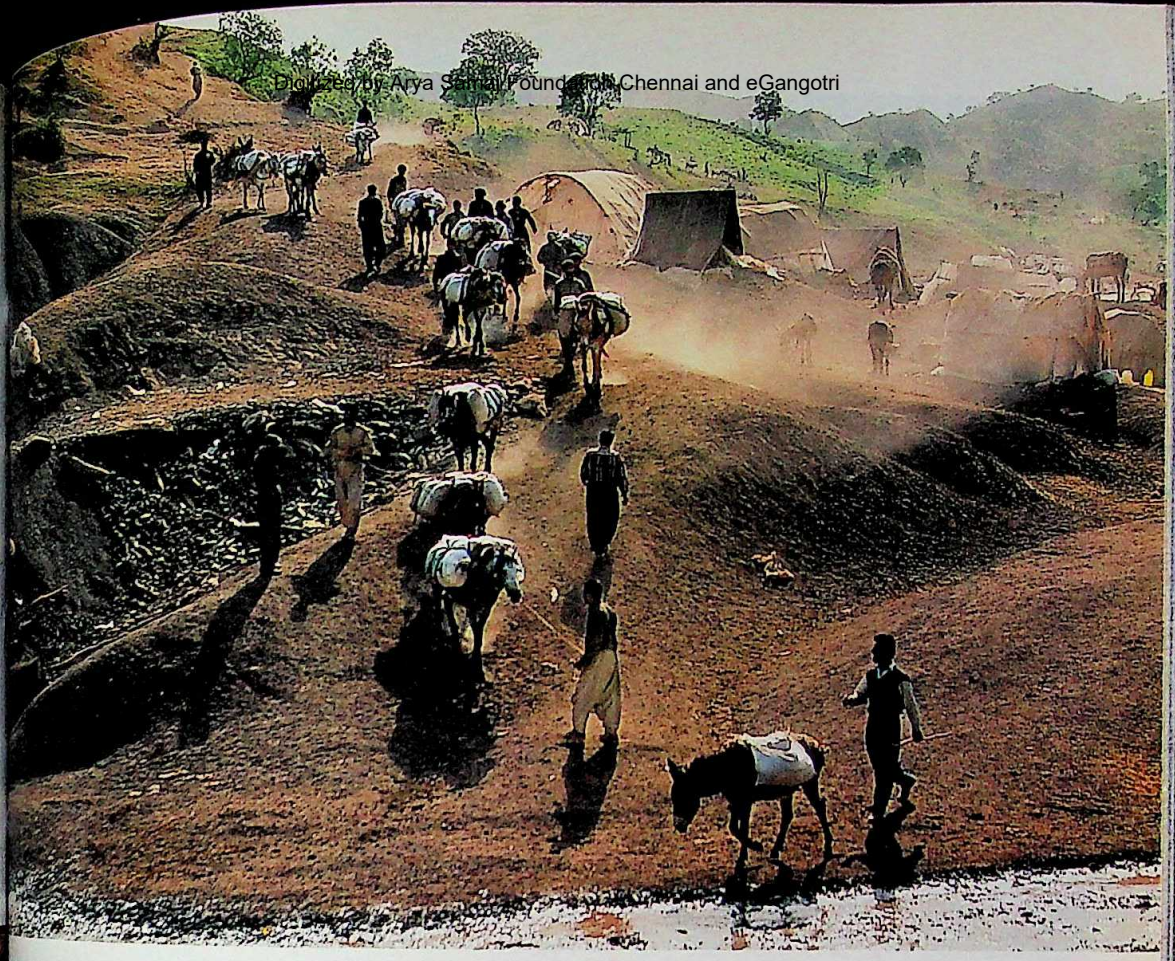

Borderline trade practices operate on the Iran-Iraq frontier as a Kurdish mule train loaded with UN rice and milk powder prepares to slip into Iran. It will return with manufactured goods. Thirty dollars buys a rifle in a border village (opposite). Fifty cents gets a grenade. "Good for fishing," says the seller.

paradise: a soldier with a Kalashnikov.

The garden lies beside the Tigris where it joins the Euphrates to create the Shatt al Arab, or Arab River. The soldier stood guard as I went into the walled enclosure. Just a postage-stamp park, it harbored an ancient gray snag of a tree, long dead, which some Iraqis believe is as original as original sin. Near it grew a healthy younger one. Neither would have produced an apple for Eve to pluck; they yield a plumlike fruit, the *nabug*. Still, many Muslims regard this spot as sacred, for in Islam Adam is a prophet.

Like Adam and Eve expelled from paradise, thousands of Iraqis have been driven from the marshes that spread between the Tigris and Euphrates. The Marsh Arabs, or Madan, have dwelled in those wetlands for at least 5,000 years. They built reed houses, fished, hunted waterfowl, grew rice. Today many of the Madan, who may number 200,000, have fled to Iran. Iraqi helicopters and artillery blasted their villages in 1992, possibly because guerrillas had found refuge in them. It was in response to these attacks that U.S. and British planes began to patrol the southern no-fly zone. Nevertheless, earlier this year, the UN Commission on Human Rights reported new assaults by Iraqi ground forces using mortars and artillery. Many houses were burned or bulldozed as Saddam forced the Madan to move into collective towns where they could be controlled.

Worse in the long run, Saddam is draining the wetlands that sustained the Madan way of life. As a result almost all of the New Jersey-size Madan homeland is already dry.

Mohammed took me to a Madan village—on dry land—to meet Sheikh Abbas Chiad Al-Imara, leader of a tribe, as he told me, of "3,000 fighters." I sat cross-legged on a carpet beside the sheikh, a handsome man in a gold *abae*, or robe. Twenty tribesmen joined us.

"Now that the people are moving to towns, the government will bring us electricity and schools," the sheikh said. "What is happening is

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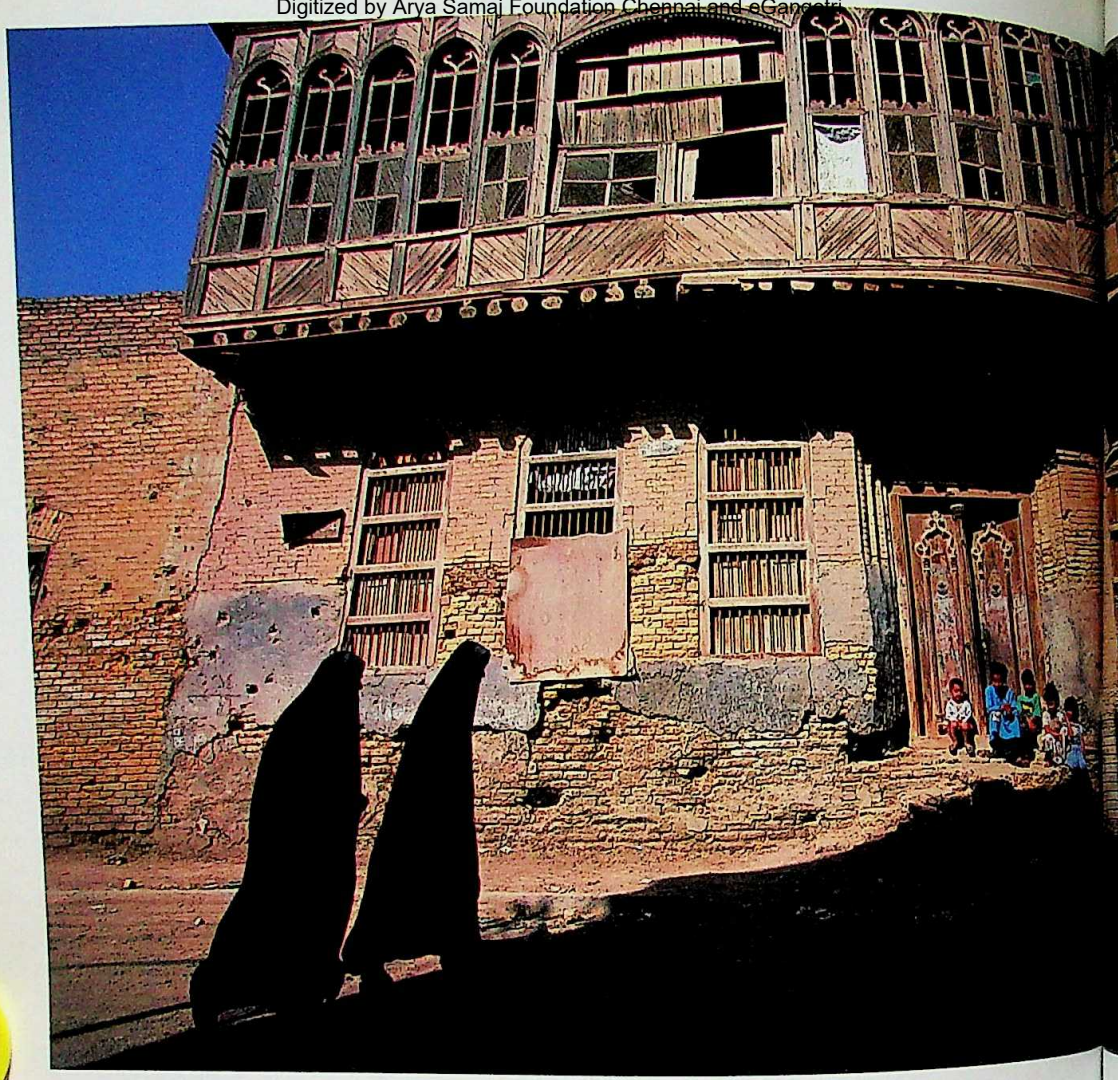

good for us." I looked at the tribesmen around us. Their bladelike faces registered neither approval nor protest. UN reports say some Madan are being held hostage by the army to assure tribal obedience; perhaps kin of these men were among the prisoners.

CENTURIES ago ships from India sailed up the Shatt al Arab from the Persian Gulf, bringing gems and spices to Basra. More recently—before 1991—the city's casinos and bars drew Muslims from nations where such things were forbidden. None of that sparkle survives; Basra has shrunk into a shabby city of dust-colored dwellings and make-do sidewalk bazaars.

In a hotel by the river I listened at night to cars clack-clacking across loose sections of a pontoon bridge. Destroyed in the gulf war, Basra's bridges, unlike those of Baghdad, have never been rebuilt. Nor has Basra's port been cleared of ships sunk by Iranian artillery in 1980. Iraqis say such neglect is the price Basrans pay for rising against Saddam in 1991. "One of the biggest factors in Saddam's mentality is revenge," said a dissident now living in London. "He will never forgive them for revolting." Revenge motivated the Basrans as well; in 1991 many slew security agents and Baath Party officials to avenge the deaths of relatives.

In the 13th century Marco Polo wrote that Basra grew "the best dates in the world." In modern times dates were a major export. But close to the Iranian border, where great plantations had stood, I saw only miles of stumps, all that was left after Iraq and Iran fought savagely in this area in the 1980s.

Seven hundred families had lived in the village of Sihan, but only one dwelling remained. In its yard I saw boxes of corroding

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The gloom deepens in war-scarred Basra, a once booming port city in the south, where merchants' houses now decay from neglect. Saddam has let the city rot as punishment for being a center of opposition during the 1991 uprising of the south's predominantly Shiite population. Hatred of the Sunni-led ruling party persists, evidenced by sporadic riots and bombings.

ammunition. "We collected those around the house," Ihsan Baki said casually. He was shoeless; such money as he earns today comes from fishing. In land, at least, Ihsan and his brothers were well off, with 59 *donems*, or 36 acres. "Our grandfather planted many of the date palms that were here," he said. "We harvested 150 tons of dates a year. We had orange and pomegranate trees too." All gone, destroyed in the Iraq war. Ihsan and his brothers are slowly replanting palms, but Ihsan believes 20 years will pass before they harvest 150 tons again.

IN NORTHERN IRAQ the writ of Saddam extends only a few miles beyond the city of Mosul, whose old quarter rises from the Tigris like a tottering stack of crates. In 1991 Iraqi officials as well as troops withdrew from the country's three northern governorates, the mountainous heart of Iraqi Kurdistan, as the Kurds rose in a new anti-government campaign.

Passing through a couple of military checkpoints, I felt as if I had entered a different country. Kurds were running the three governments; Kurds were the police. They didn't require me to travel with a minder. Even the language changed; a distinct ethnic group, Kurds speak a tongue laced with Persian.

An ancient citadel rises in Arbil, one of the chief Kurdish cities, and from a café there I looked across jumbled roofs. Satellite dishes peered back; unlike other Iraqis, Kurds receive news from all over the world.

Blue-and-white signs announced UN agencies that were helping Kurds recover from decades of war and neglect. WFP distributed food, UNESCO built schools, UNICEF cleaned water supplies. A poultry farmer named Hamadamen Kadir thanked FAO for the soya meal that fattened his 7,000 broilers. The oil-for-food program paid for everything.

Life is much improved for Kurds, but they are, as ever, disunited and prone to settle disputes with guns. Everyone seemed to have a Kalashnikov. I saw two women at a wedding with rifles slung on their shoulders, and when I looked into the car that would whisk the new couple away, I saw a rifle on the front seat. Some Kurds carried weapons because their families were involved in feuds, others because they were *peshmerga*—warriors.

"If something happens suddenly, we are ready," said a peshmerga, strolling through a bazaar with his weapon. He belonged to the militia of the Kurdistan Democratic Party, or KDP. Its chief rival for control of Kurdish affairs is the Patriotic Union of Kurdistan, or PUK. They've fought several battles since Iraq pulled out, and although they've agreed to cooperate, it's plain they don't trust each other. KDP leaders are crooks, a PUK official told me. A KDP official said Iran is supplying arms to the PUK. Could be. Iran, Syria, and Turkey, which have Kurdish minorities, have long been accused of meddling in Iraqi Kurdistan to assure that the situation remains unstable.

"They don't want to see us [Iraqi Kurds] get autonomy," one KDP official said, "because then their Kurds will demand that too." Both the KDP and the PUK say their goal isn't independence from Iraq but the right to control their own affairs—under a government not

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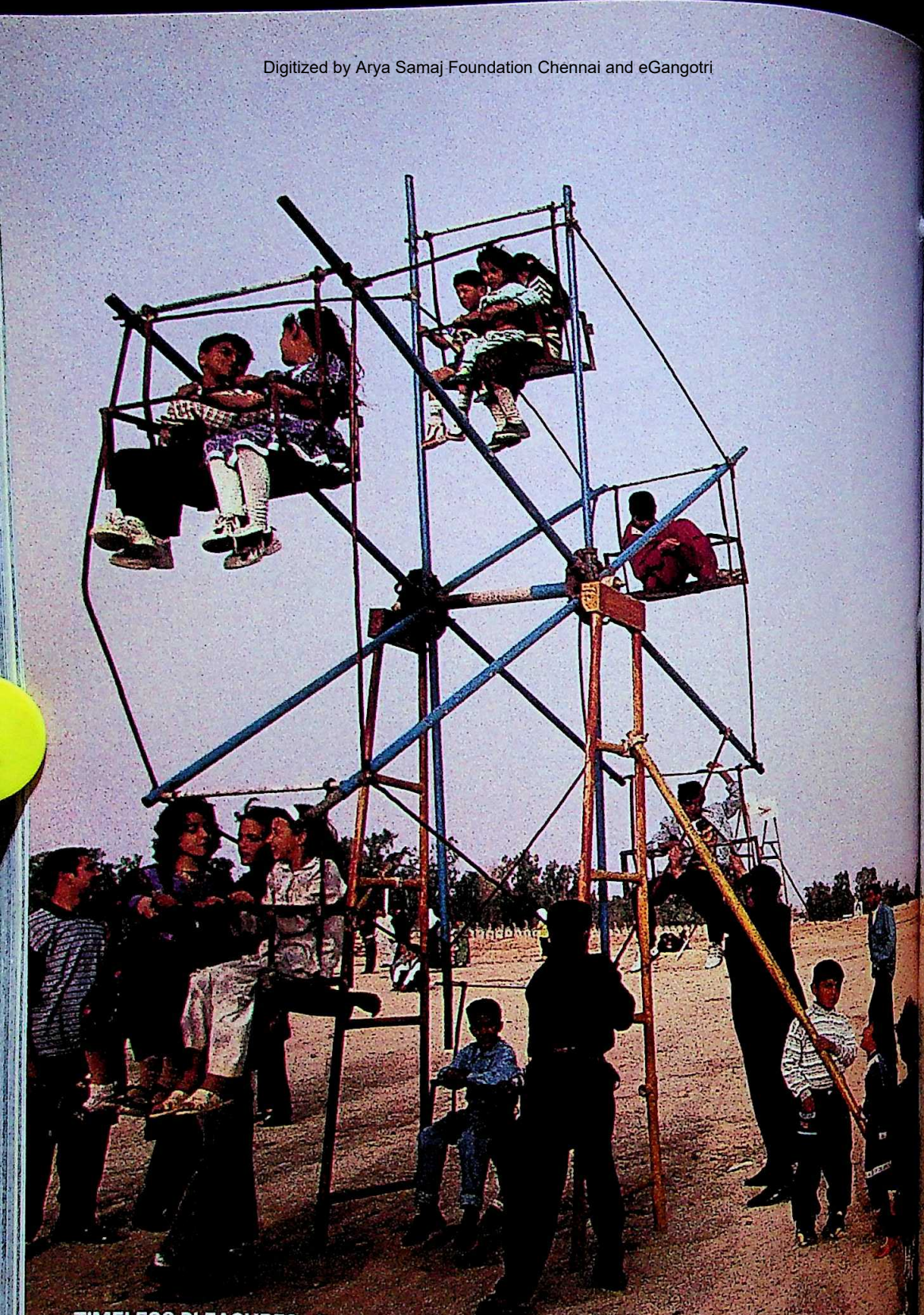

TIMELESS PLEASURES of a playground divert families visiting the ruins of Samarra, a ninth-century capital of the Abbasid dynasty, rulers of Iraq for 500 years. An enormous spiral minaret commands the site.

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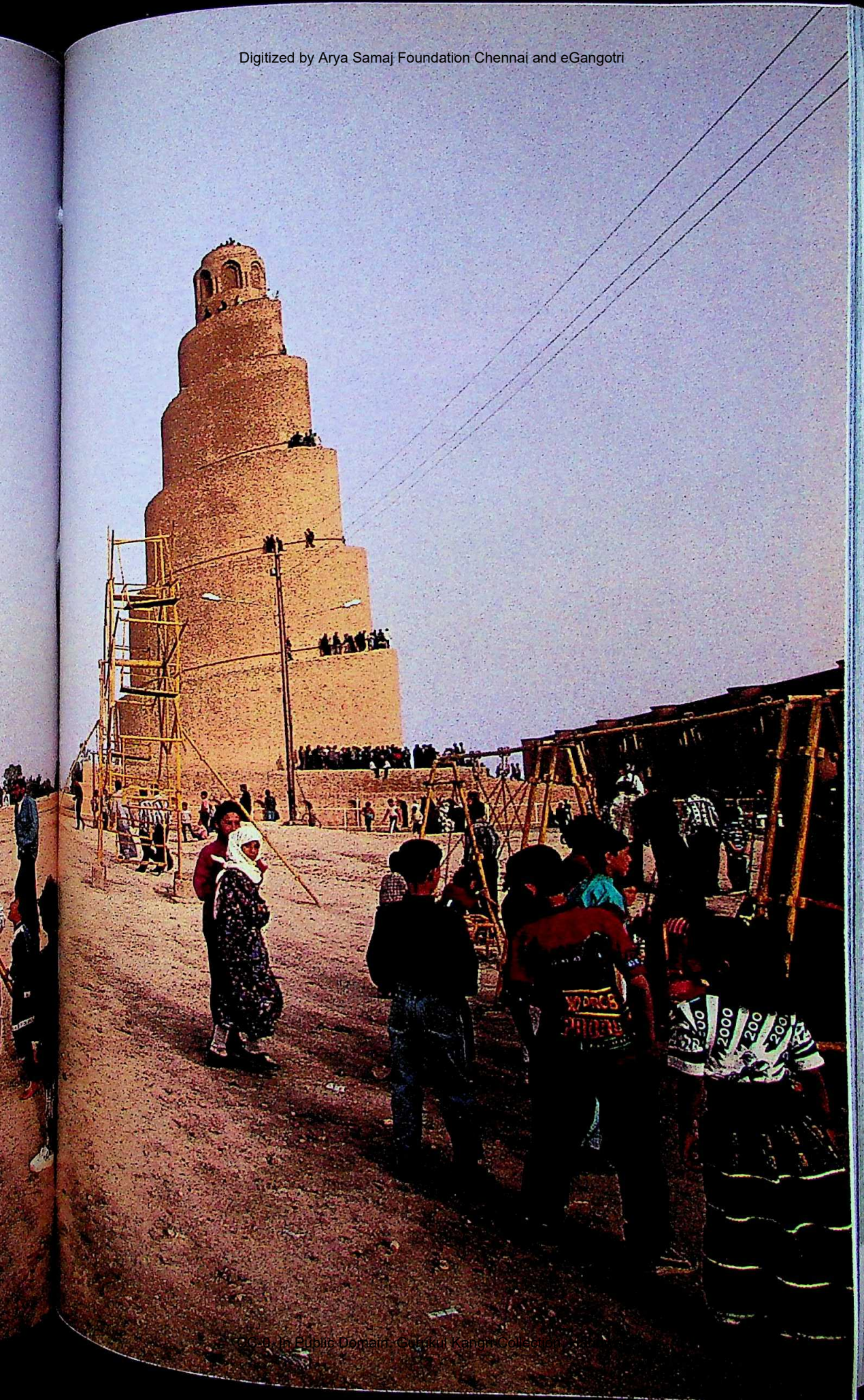

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run by Saddam Hussein, of course. Turkish Kurds have long fought to establish an independent domain, sometimes engaging in terrorism.

I went northeast to the small city of Diana, about halfway between Arbil and the Iranian border, on a road that climbed corrugated mountains ribbed with limestone. Beneath these bony ramparts young wheat struggled to get a roothold in fields of rubble.

Diana's bazaars brimmed with cheap Iranian carpets and plasticware. Other shops offered arms. Want to see something in hand grenades? How about these? Fifty cents apiece. Land mines? Same price.

Everyone who fought in these mountains—Iraqis, Iranians, Kurds—laid mines. Millions remain in the earth. In a village of mud and stone, a man showed me his hands. Five digits were missing. He had also lost an eye. "I was trying to clear a field so I could plant," he said. "I saw this thing and I lifted it and. . . ."

A thin woman standing in a doorway said, "Seventeen people of this village have been killed or hurt by mines. This child's father"—she put a bony hand on a boy about ten—"was one of those killed." The boy looked at me with large, sorrowful eyes.

"Clearing the mines could be a matter of life and death for these people, not only because they might be killed but also because they need the land to farm," said Graeme Abernethy, who was with me. Trained as a sapper in the New Zealand Army, Graeme led a team of de-miners brought in by the UN to teach their hazardous craft to Kurds.

"If you take out one mine, you may save the life of one person," said Reger Sabah, a Kurdish de-miner. "It is not dangerous if you are careful." Reger earned $150 a month—good pay in Kurdistan. He wore a heavy Kevlar torso cover and a plexiglass face guard. Standing well away, I watched him work. On his knees he marked off an area measuring about one foot by three feet. He checked for trip wires, trimmed the grass, and gently felt the earth. Finally he passed a metal detector over the area. Satisfied, he advanced another foot. In a day he'd cover perhaps ten square yards. Dogs that sniff explosives can cover more territory, and some are being trained in Diana now.

So far the UN has spent more than six million dollars (from Iraqi oil money) but has sanitized only a fraction of the 3,000 known fields. Decades will pass before Kurdistan is cleared—if ever—of mines, grenades, unexploded mortar shells, and other ordnance.

A finger-pointing war memorial lines the Shatt al Arab near Basra on the Iran-Iraq border. The 61 statues represent military commanders who died during the 1980-1988 Iran-Iraq war, which ended in stalemate. With its economy in tatters, its youth mired in ignorance and disease, and its leader a brutal tyrant, Iraq remains in full-scale retreat from the glories of its past.

Some Kurdish farmers, meanwhile, are moving into new homes. The UN agency known as Habitat has supplied materials for rebuilding 1,100 of the more than 4,000 villages destroyed by Iraqi troops in the 1980s. In one, Shorawa, I sat on a carpet drinking tea with Khawam Karim, a bluff fellow with a sun-bronzed face. Khawam's family had lived in Shorawa for "20 grandfathers," as he measured time. In 1987 soldiers drove out the villagers. "We were made to go live in a collective town," Khawam said, "even though we hadn't done anything against the government." Saddam had concluded that the Kurds might be controlled if corralled—the same treatment the Marsh Arabs are getting now.

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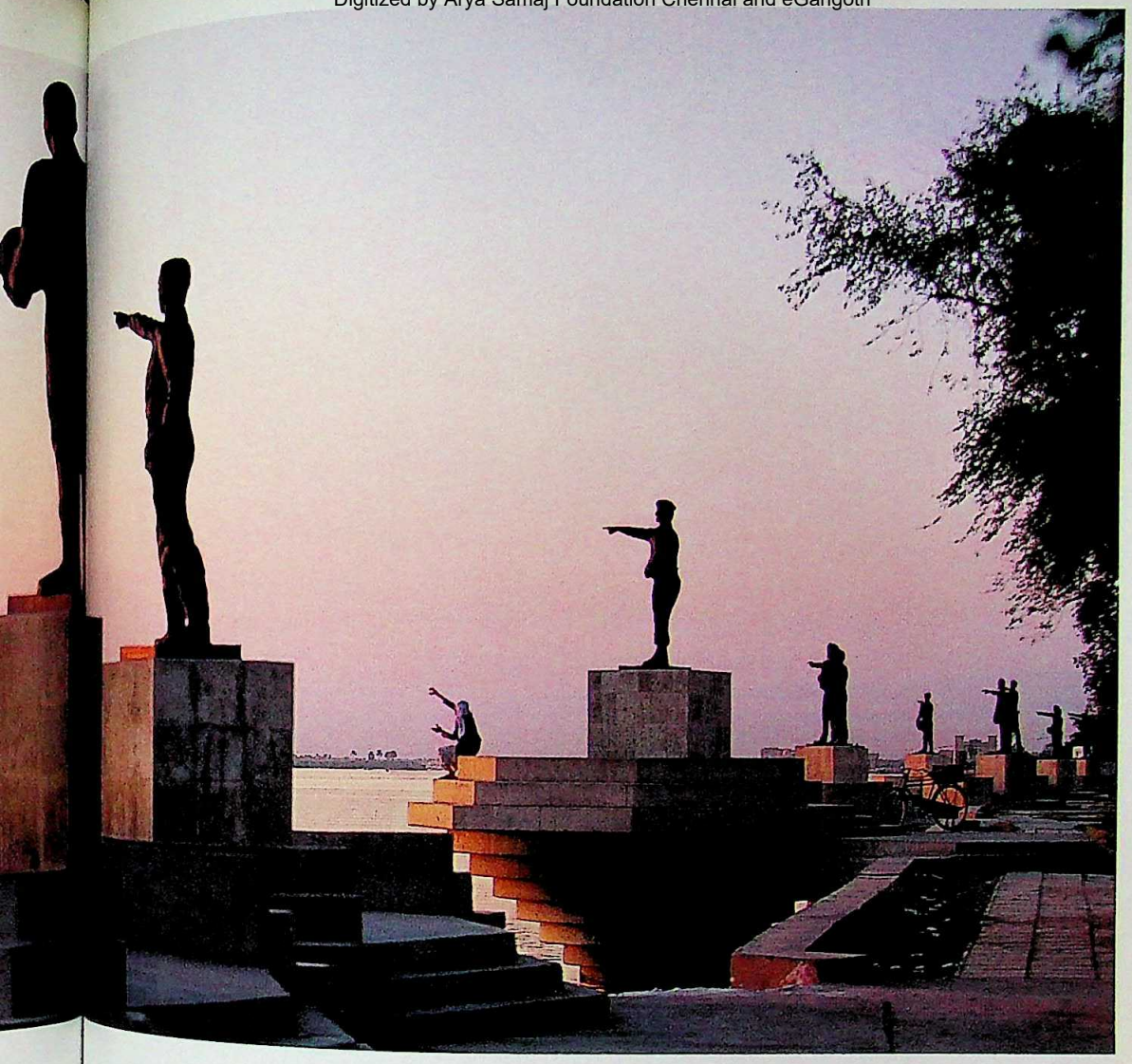

I asked Khawam if he was afraid that Saddam's soldiers would return some day. "It is not in our power to prevent that," he answered. And then, looking hard at me: "The situation is in your hands—you Americans."

Many Kurds wonder how long they will be protected by U.S. and British aircraft patrols. Friends have abandoned them before when Middle Eastern alliances shifted.

THE TRIP BACK to Baghdad took me through Kirkuk. Around the city half a dozen infernos blazed, burning waste gas from one of Iraq's major oil fields. Iraq has more petroleum reserves than any other nation except Saudi Arabia.

Reminded of that wealth, an engineer told me one day: "Once we hoped that by the end of this century Iraq would be an advanced country, that it would move up from the Third World group. We could contribute something to the world in any field—science, the arts—because we have the background. We have 7,000 years of history. We introduced mathematics; we watched the stars and made a calendar." And invented the wheel. And writing.

Oil indeed could have made Iraq a modern nation. Oil could have bought anything. But it did not buy peace. Instead it paid for weapons. And when Saddam threatened the West's main oil suppliers in the Persian Gulf, Iraq found itself a defeated state and a pariah.

In some future time archaeologists will scour the record of Iraq at the end of the 20th century, as they have scoured the records of King Sargon, who founded the first Mesopotamian Empire, and Hammurapi of Babylon, the giver of laws. And when listing the achievements of Saddam, they will write: He built a lot of palaces. □

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TIGERS IN FOR THE KILL

TIGER SHARKS CAN MAKE LIFE BRUTAL AND BRIEF FOR ALBATROSS CHICKS LEARNING TO FLY AT HAWAII'S FRENCH FRIGATE SHOALS.

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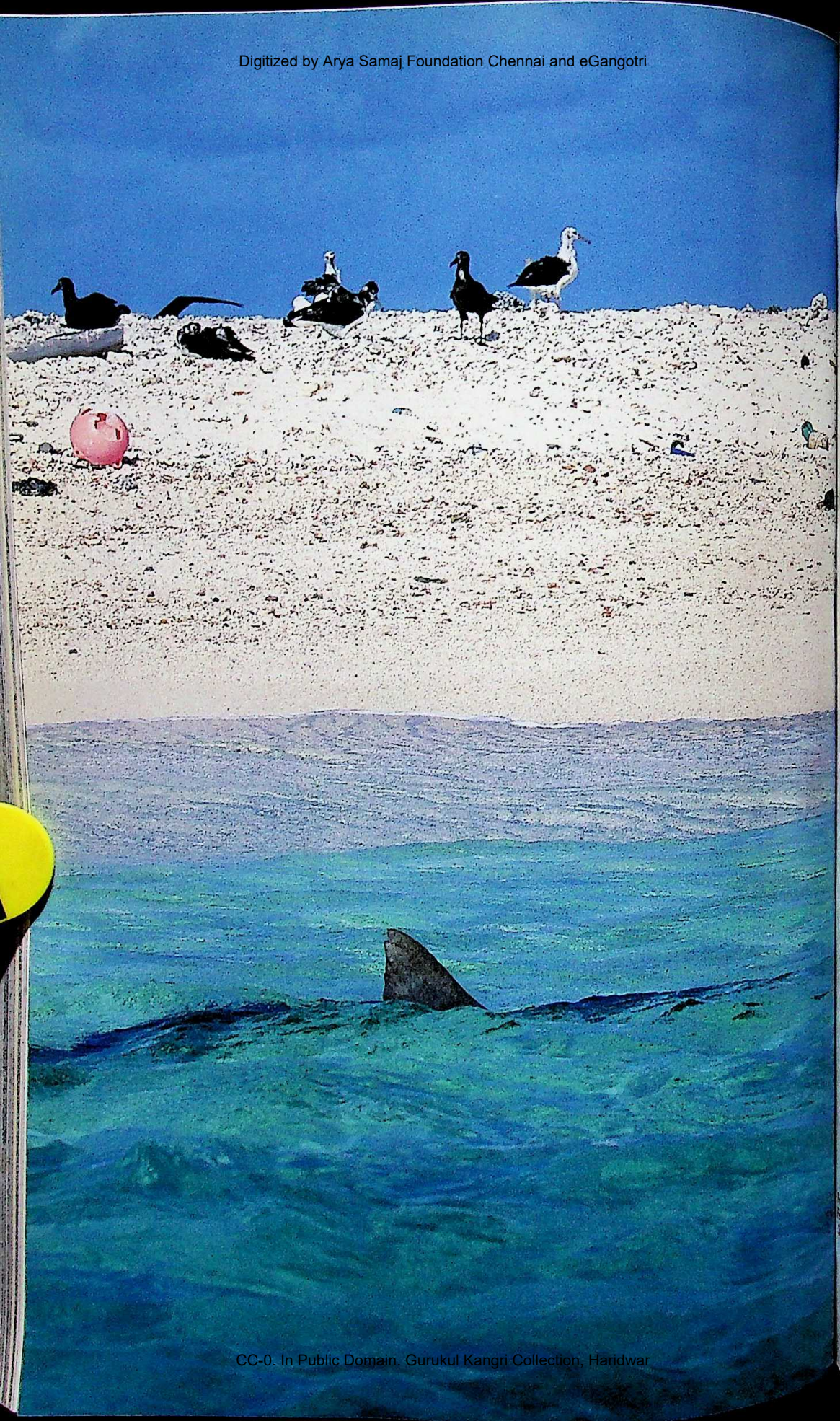

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Article and photographs by
BILL CURTSINGER

From an anchored boat I scanned the shore of East Island for albatross chicks. There were plenty to see. These largest of seabirds spend most of their lives far at sea, but at nesting time they concentrate ashore on remote islands like this one, at French Frigate Shoals in the Hawaiian Islands. Two albatross species, the Laysan albatross and the black-footed albatross, had hatched their chicks four or five months earlier.

I had not come to the Hawaiian Islands National Wildlife Refuge to look for birds. I was looking for sharks—like the one whose fin showed where it was cruising a few yards from shore. These big tiger sharks show up at the peak of the fledging season, looking to eat young albatrosses lingering in the shallows. During the months of June and July the two separate worlds of bird and fish come together.

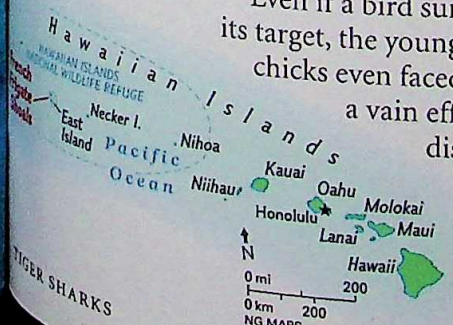
Oblivious to the danger, the 30 or 40 chicks knew only that their departure time was now. I watched as some of the birds caught the wind, sailed out clumsily over the water, gained momentum, and flew off into the wild blue yonder, safely beyond the danger zone. Others landed a mere 30 yards from shore, where the situation was wilder. A shark would move in and a hapless chick would disappear in a microsecond, before I could even raise my camera. These unfortunate birds, which were not in the majority, simply landed in the wrong place at the wrong time.

Two species of albatrosses—Laysan (above) and black-footed—fledge at about five months. But when flying from land to sea, they face a life-threatening hurdle—a hundred feet of water alive with tiger sharks, which migrate here each June to prey on the birds.

Tiger sharks routinely start feeding at twilight, but here they fed on albatross chicks all day. The morning of June 20 was a fairly typical one. Between 6:45 and 7:45 a.m. three Laysan and thirteen black-footed albatross chicks flew from the beach at East Island. In that hour five of the sixteen fledglings were attacked and killed. Another was attacked and escaped. As the day progressed, more wind meant more flights. And the stronger winds gave the birds an extra edge, lofting them far offshore, beyond the danger zone. The victims would fly, splash down, and preen their wings, unaware of the danger until disaster struck.

The sharks were often not as efficient as one might expect. I saw them miss their prey by several feet on the first try, spiral around for another assault, and zoom in for the kill. Sometimes the chick would get away before the second attack. One distinctive shark with a knob on its dorsal fin wheeled around for a second pass. Not seeing the bird, it slammed into my small Boston Whaler and attacked the outboard propeller. This was discouraging since I prefer to dive with sharks to photograph the underwater action. Based on the behavior of this particular shark, I decided to use a remote camera system from topside.

Even if a bird survived an initial attack because the shark missed its target, the young albatross would often stay on the water. Some chicks even faced their pursuer and feebly pecked at the shark in a vain effort to ward off the 14-foot predator. Then they disappeared, dragged underwater, swallowed whole. A few feathers remained drifting in the water along with bits of flesh that sank slowly to the bottom, erasing all evidence of the recent drama.



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First flight is the last flight for one out of ten fledglings. The unfortunate novice fliers are often the scrawniest ones or those that try to ride whispers of wind too weak to carry them over the danger zone.

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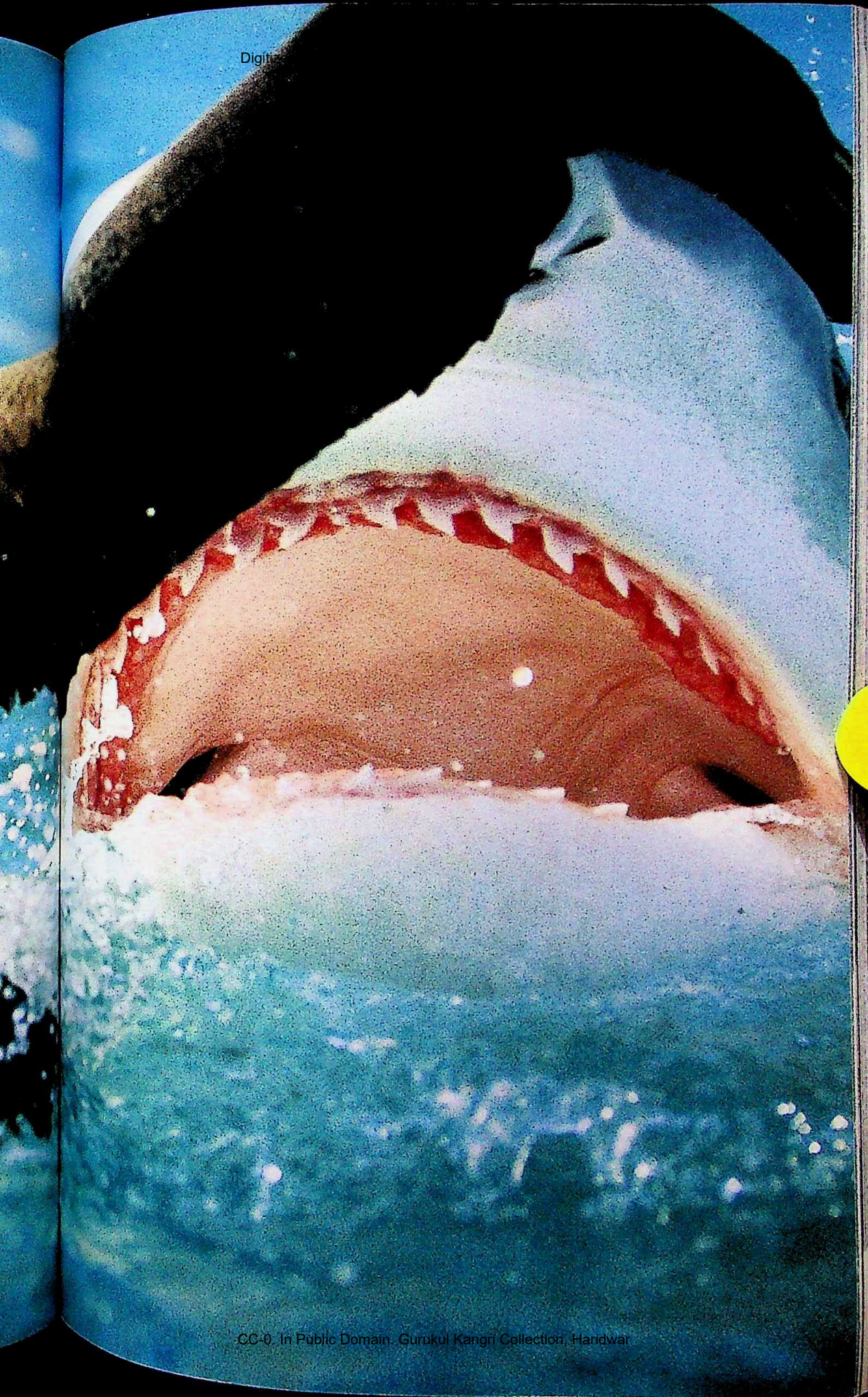

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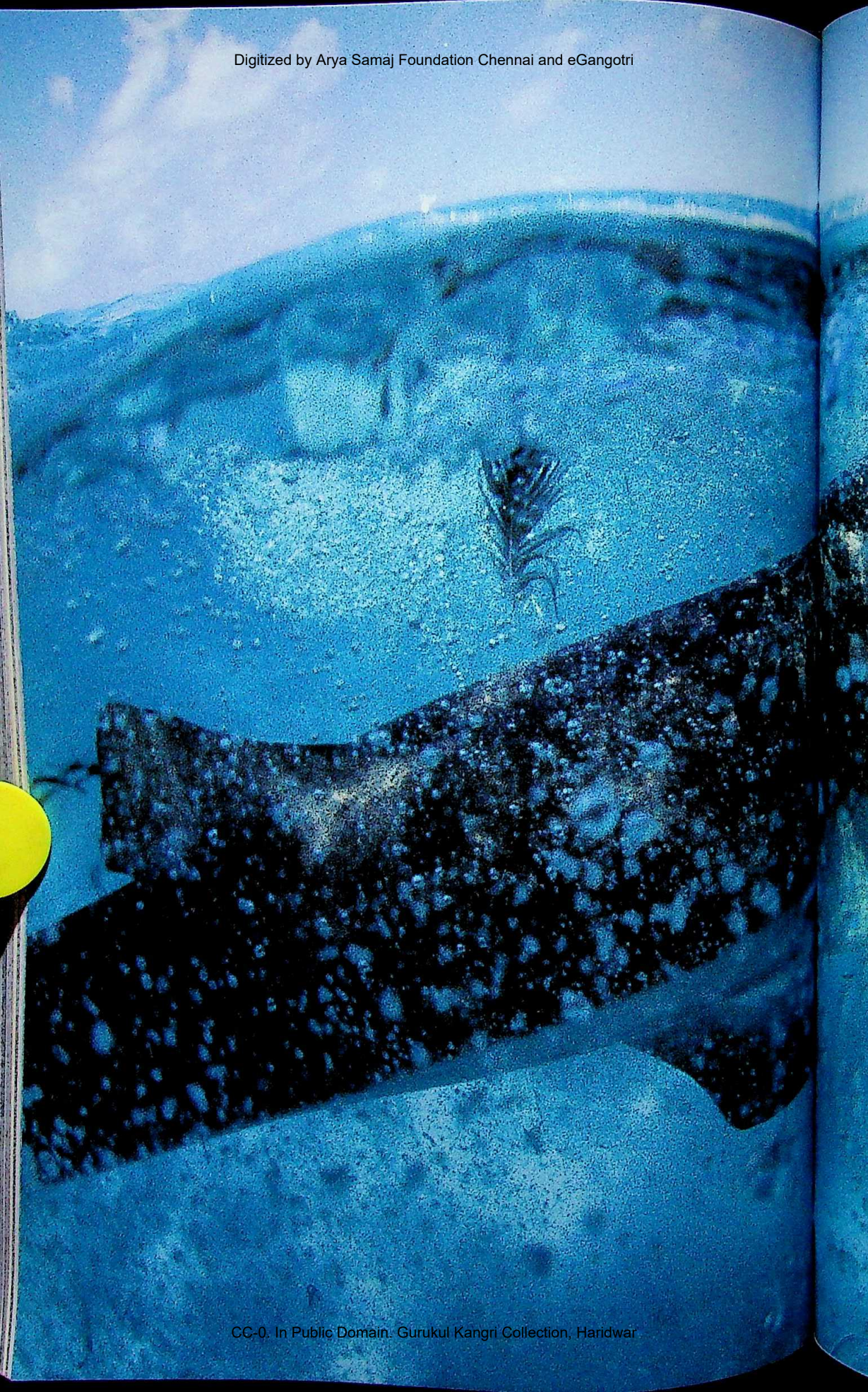

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Feathers float in a tiger's wake, a familiar scene near albatross roosts. "It's rare to actually see sharks feeding in a natural setting like this," says photographer Curtsinger. "They were just snacking, but capturing this was a feast for me."

Bill Curtsinger photographed "Pirates of the *Whydah*" for the May 1999 issue.

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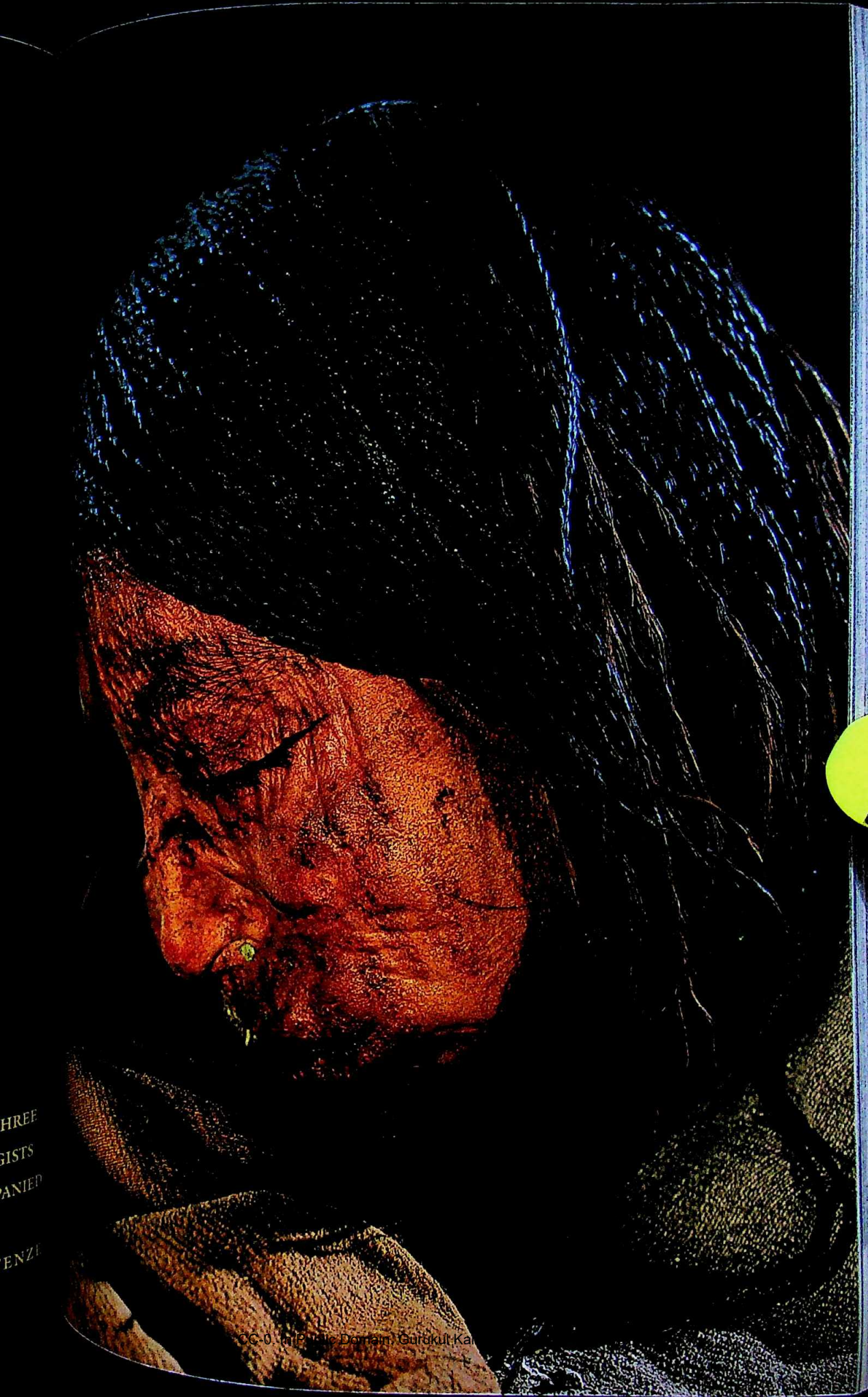
AT
22,000 FEET

CHILDREN OF INCA SACRIFICE FOUND FROZEN IN TIME

FIVE CENTURIES AFTER INCA PRIESTS SACRIFICED THREE CHILDREN ON A PEAK IN ARGENTINA, ARCHAEOLOGISTS FIND THEM FROZEN TO NEAR PERFECTION, ACCOMPANIED BY BREATHTAKING TEXTILES AND ARTIFACTS.

By JOHAN REINHARD *Photographs by* MARIA STENZEL



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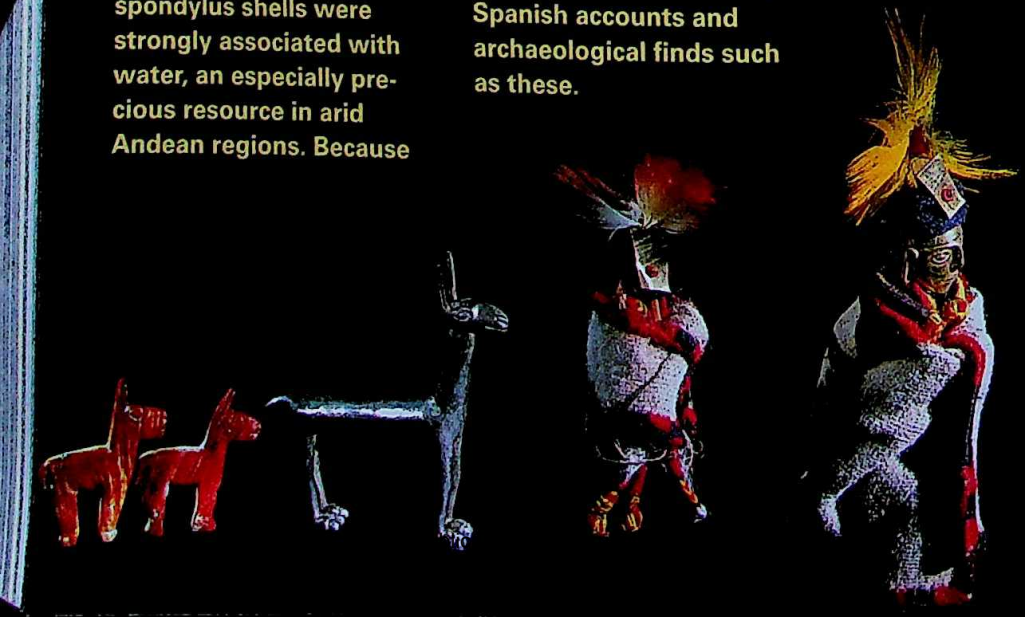
Eternity Bound

Richly wrapped Inca child sacrifices were more than just gifts to the gods. They were ambassadors, sometimes volunteered by their families, sometimes taken from them. The boy found on Cerro Llullaillaco (right), perhaps eight years old, wore a tunic big enough to grow into, carried extra sandals for his journey in the next world, and bore a gift more prized than gold: a spondylus-shell necklace (above). Harvested off Ecuador's warm shores, spondylus shells were strongly associated with water, an especially precious resource in arid Andean regions. Because mountain gods controlled weather and gave or withheld life, these peaks were fit settings for sacred rites.

The figurines below—two males and three llamas, shown here about three-fourths their actual size—may have been offerings to the gods, representations of the sacrificial victims, or even guides to the afterworld. No one knows, since the Inca left no written history. Most of what is known of their culture comes from early Spanish accounts and archaeological finds such as these.



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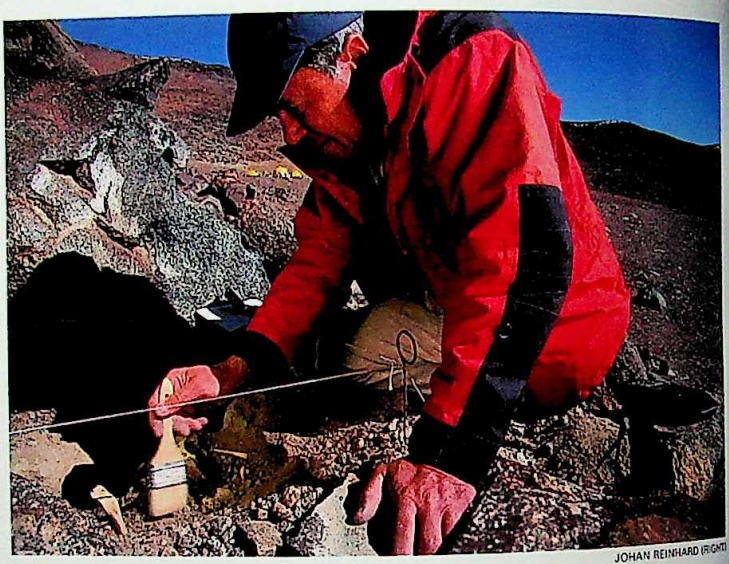
ARCADIO MAMANI is one of the strongest men I've ever worked with. He grew up in the mountains of southern Peru and has accompanied me on a dozen high-altitude archaeological expeditions, including three to the Ampato volcano, where the Inca Ice Maiden was found in 1995.* Lean and muscular, Arcadio has phenomenal endurance: He often keeps digging long after other team members stop. A proud follower of his family's traditions, which have roots in those of the Inca themselves, he is always the one to make offerings of food and drink to the mountain gods, asking support for our work. And indeed Arcadio seems to have developed a sixth sense about archaeological sites.

This time we were excavating Inca ruins on the summit of Cerro Llullaillaco (pronounced Yu-yai-YA-ko) in the Andes. At 22,110 feet it is the world's highest archaeological site. We had waited four days for fierce winds and a snowstorm to abate while encamped in a snow bowl 200 feet below the summit. This was followed by a day and a half of digging. It seemed only fitting, therefore, that Arcadio was the first to shout the word that caused all of us to stop work instantly: "Mummy!"

I put down my notebook and hurried over to the place where Arcadio was digging. He and his brother Ignacio had uncovered a section of a stone-and-gravel platform on the most exposed part of the summit. There, more than five feet down, was a bundle wrapped in textiles—the frozen body of an Inca ritual sacrifice, a boy about eight years old. Beside his left arm lay a sling and two pairs of sandals, objects presumably intended to accompany him on his journey to the afterlife. Parts of his arms, hands, and feet were visible and were in excellent condition; his knees were drawn up in a fetal position and bound tightly with a cord. He wore moccasins and white fur anklets, which looked as if they'd been made only yesterday. A broad silver bracelet covered his right wrist.

I felt a surge of exhilaration, followed by intense relief. Only two weeks earlier we had excavated an Inca ritual site at 20,112 feet on the summit of Nevado Quehuar, not far from Llullaillaco, where we found the battered remains of a human sacrifice. Treasure hunters had preceded us. To save time, they had used



JOHAN REINHARD (RIGHT)

Excavating a burial ground near Base Camp, the author (above) takes a breather from the work on the summit, another 6,000 feet up. While this lower site had been raided by treasure hunters, the much less accessible summit (right, foreground) had kept looters at bay long enough to protect the highest Inca sacrifice ever found.

Anthropologist JOHAN REINHARD is an explorer-in-residence at National Geographic. MARIA STENZEL is a frequent contributor, whose photographs of "Vanishing Cultures" appeared in the August issue.

*See the author's story on the mummies found on Ampato in the June 1996 NATIONAL GEOGRAPHIC.

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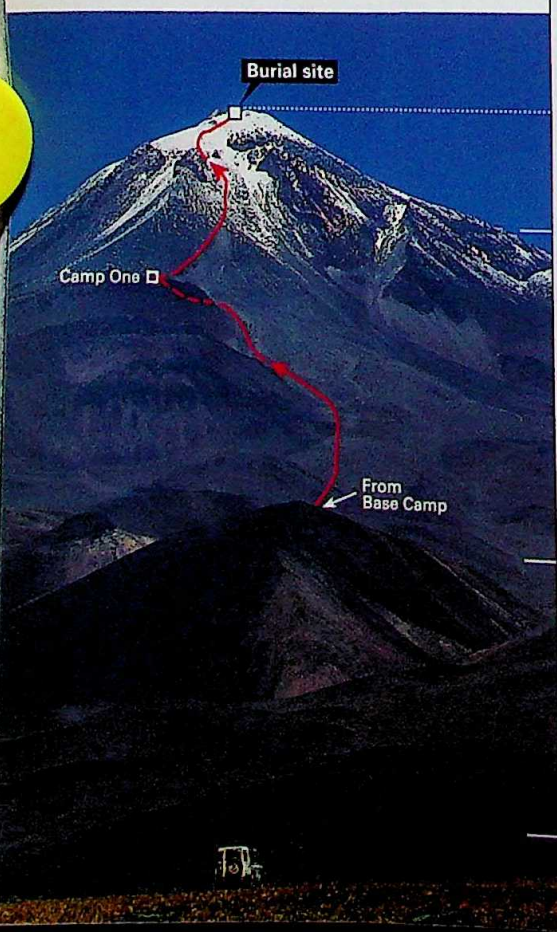
The Inca Empire

In its short life of only about a hundred years, the Inca Empire came to stretch 2,500 miles—roughly the distance between New York City and Los Angeles. By the Spanish conquest in 1532 the Inca, a small ethnic group based in Cuzco, Peru, ruled more than 12 million subjects, of 100 different cultures, speaking at least 20 languages. The Inca were not the brutal conquerors the Spaniards were. They used gifts as well as spears to demonstrate power to potential subjects. Inca textiles, for example, inspired awe among villagers. Once in charge, the Inca assimilated new peoples with remarkable effectiveness—allowing local leaders to keep their posts but taking their sons to Cuzco for training, exacting a "labor tax" from subjects but repaying with goods, honoring local gods and religious practices but commingling them with Inca beliefs and rituals. Child sacrifices were part of this approach. The Inca obtained children from throughout the empire and rewarded their families with positions or goods. Sacrifices were unifying events; children often were taken to Cuzco for celebrations before processions bore them on long journeys and up massive mountains to sacrifice sites.



COLOMBIA
ECUADOR
Quito
Cuenca
Tumbes
Amazon
Cajamarca
Chan Chan
Huánuco Pampa
PERU
Jauja
Lima
Pachacamac
Machu Picchu
Cuzco
BRAZIL
BOLIVIA
Nevado Sara Sara
Volcán Misti
Chala
Nevado Pichu Pichu
Nevado Ampato
La Paz
Arica
Sucre
Tupiza
Pacific Ocean
Catarpe
San Pedro de Atacama
Tilcara
Nevado de Cachi
Salta
Cerro Llullaillaco
Burial site
Pucara de Andagua
CHILE
Chilecito
Cerro del Toro
Cerro Aconcagua
Cerro El Plomo
Santiago
ARGENTINA
ANDES
Inca mummy site above 17,000 ft (5,182 m)
Inca site
Present-day settlement over Inca site
Inca Empire at its height A.D.1525
Inca road
0 mi 200
0 km 200
NG MAPS

Mt. Everest
29,028 ft
8,848 m

Cerro Llullaillaco
22,110 ft
6,739 m

Mt. McKinley (Denali)
20,320 ft
6,194 m

Mont Blanc
15,771 ft
4,807 m

Mt. Fuji
12,388 ft
3,776 m

GORDON WILTSIE (LEFT)

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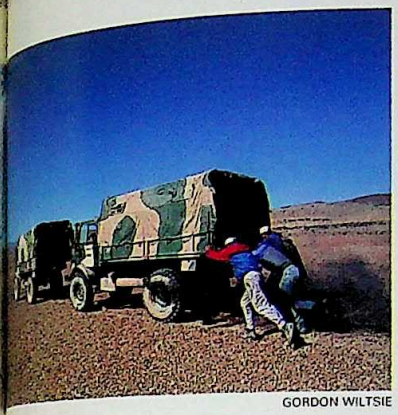
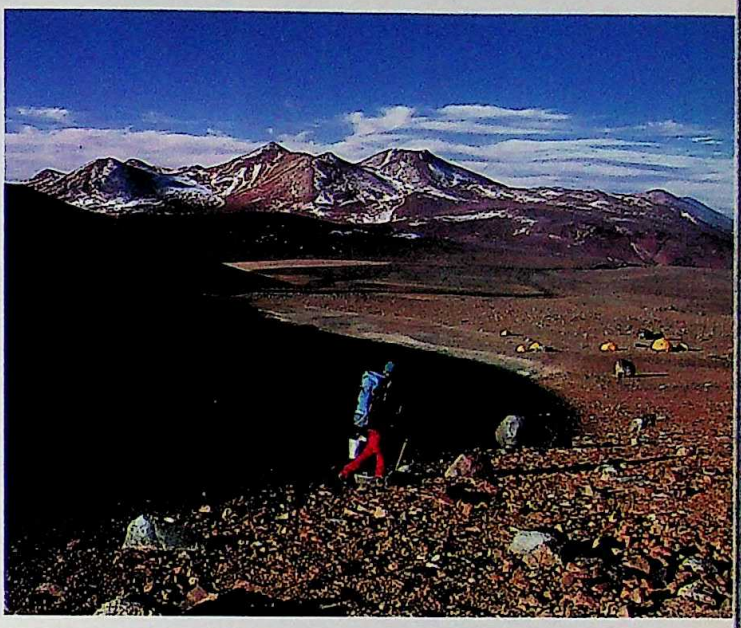
As we worked our fingertips became raw.



GORDON WILTSIE



Nearly 2,000 feet higher than Alaska's Mount McKinley and 100 miles from the nearest town, Llullaillaco (opposite) took five bone-jarring driving days to reach—with breakdowns. A truck with a dead battery is pushed back to life (above left) on the way to the 16,000-foot Base Camp. A team member races nightfall back to camp (above) after exploring a nearby Inca ruin.

dynamite to break open the grave, blowing the mummy's head off in the process. I was anxious to prevent such destruction on Llullaillaco. The sad reality is that few high-altitude sites in the Andes have escaped some looting—it's impossible to guard all routes to the summits of massifs like Ampato and Llullaillaco. The only way I see to ensure that the contents of these burials are not lost forever is for archaeologists to excavate and preserve them.

Twice again during 13 arduous days on the summit, I would experience the pulse quickening that comes with a landmark discovery. In addition to the boy, we unearthed two more frozen Inca sacrifices, both girls. Until then the only other well-preserved Inca female mummy to have been recovered was the Ice Maiden. With the Llullaillaco finds we tripled the number. We also found 20 clothed statues, half as many as were previously known. Each was found undisturbed in its proper context in the ground—an archaeologist's dream.

Later, when Carlos Previgliano, a radiologist at the State Computer CT-scan Society in Salta, Argentina, performed CT scans on the bodies, he said they looked like "people who had died and been frozen a short time ago." As such, the children of Llullaillaco are in a category of their own, and I doubt that more perfectly preserved mummies will ever be found.

The Inca presence in this region is thought to have begun sometime after 1471, and it lasted until the Spanish conquest in 1532. I had climbed Llullaillaco twice in the mid-1980s and had surveyed Inca ruins leading to it from 15 miles distant. I knew that to have any chance of success in the extreme cold and thin air on the summit, I would need the most experienced team possible. So I recruited six of my old Peruvian partners and three Argentines, including archaeologist Constanza Ceruti, deputy director of the expedition, who had climbed 55 peaks in only three years in her search for high-altitude ruins.

We spent five days acclimatizing, ferrying loads from Base Camp at 16,000 feet to higher camps. On the ascent we investigated Inca way stations, including one at 17,200 feet that was well off the normal route used by climbers. Many of the buildings there, made of carefully laid stones, were virtually intact. We found remains of fireplaces and utilitarian pottery, evidence that the Inca had used the site as a resting place and storage facility before making their summit ascent.

By good luck the spot I chose for Camp One, at 19,200 feet, proved to have a large pool of water. Anyone who has had to heat ice to

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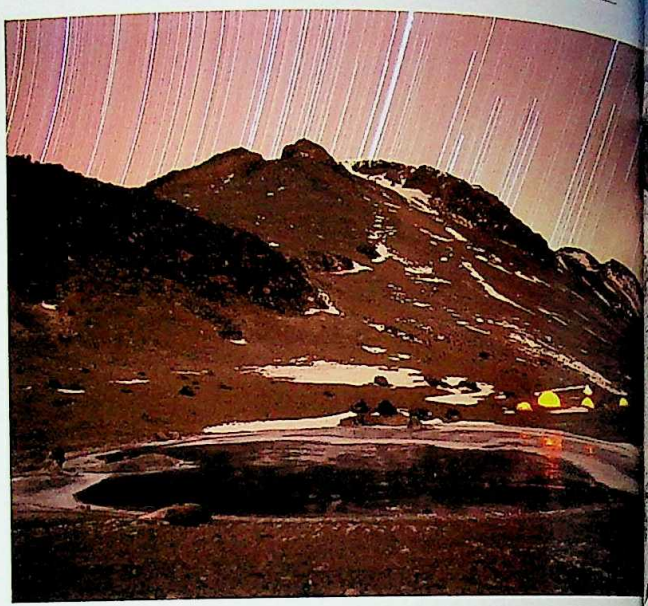
Would we find anything on the summit?



At 19,200-foot Camp One a slow-motion morning (above left) and a time-lapse night (above) conceal the difficulties encountered on Llullaillaco. On the summit the team gets socked in by a snowstorm and hurricane-force wind gusts. When all is clear, excavating begins (right) near the remains of two stone huts. The three mummies are found in bedrock crevices, buried under rock, sand, and volcanic soil, which makes the digging easier than expected (far right).

make water at high altitudes knows what a boon it is to have abundant water at hand. Although the setting made for one of the most pleasant high camps any of us had known, the effect of the altitude was brought home when one member of the group developed life-threatening pulmonary and cerebral edema. Only a hurried descent to a much lower level saved him.

Once on the summit, which is bisected by the borderline between Chile and Argentina, I first had to determine where the Inca ruins lay. Using the GPS (Global Positioning System), a compass, and a large-scale military map, I determined that all were within Argentina. Then we began working. The digging, much to our surprise, was relatively easy. High winds kept the site free of much snow, and the soil was dry and workable. Some members of the team began a competition to see how many swings of a pick or scoops of a shovel they could make before stopping to rest. This exuberance wore off by the second day, when the feeling began creeping over me that all the effort of mounting this expedition might have been for nothing. Then Arcadio found the mummy.

About two feet above the body, he unearthed three miniature llama figurines, one made of silver and two of spondylus, a thorny oyster found in the warm ocean waters off the Ecuadorian coast more than 2,000 miles to the north. The Inca may have offered the llama figurines to ensure the fertility of their herds; spondylus shells evoked the ocean and thus life-giving water. Two male figurines, one of spondylus and one of gold, had been placed in front of the llamas, as if leading them. These male statues may have represented either the deities believed to be the ultimate owners of livestock—often the mountain gods—or the Inca nobles responsible for overseeing the royal herds dedicated to the gods. A rare necklace of carved spondylus pendants surrounded the statues.

Before we'd finished excavating the boy, Rudy Perea, a Peruvian archaeology student, and Antonio Mercado, an Argentine student, uncovered another mummy a few yards away. It was a girl of perhaps 14. Beautifully preserved statues and ceramics were buried with her. The most startling object was the girl's headdress, a full-size version of one on a silver female figurine (page 53) found beside her.

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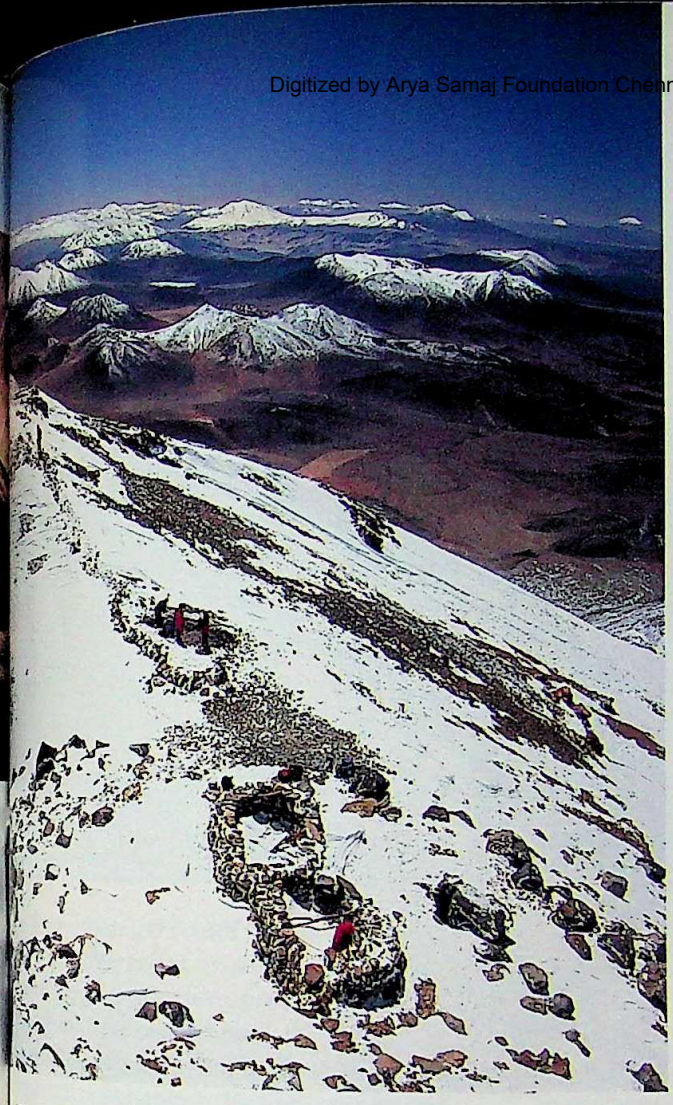

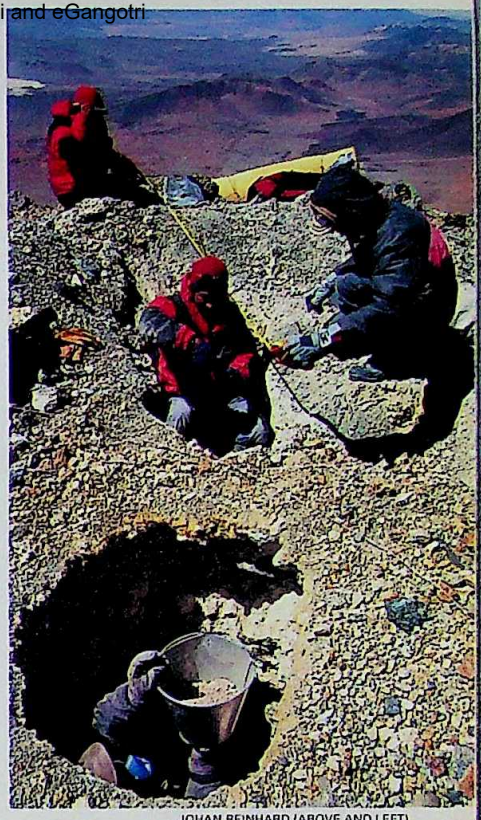

JOHAN REINHARD (ABOVE AND LEFT)

The headdresses were made of white feathers attached to a woolen skullcap.

Surprisingly, a man's tunic was draped over the right side of her body—a rare find both because of its nearly perfect condition and because of its archaeological context. Such tunics denoted high status and probably belonged to Inca nobles or were given as gifts to provincial leaders. But what was it doing with a female human sacrifice? Possibly the girl's father wanted his ritual attire to accompany her into the realm of the gods, or, as I believe, the tunic was an offering to the deity with whom, in death, the girl would reside.

Later, while we were preparing to put the mummy into the freezer at Catholic University in Salta, we examined her more closely. A hush fell over the room as I removed her head cloth, revealing her face. For an instant, time stopped while I stared in awe at her beauty. Her hair was stylishly braided, and she looked as if she were sleeping. But it was her hands, perfectly lifelike, that affected me most.

"Look under her nose; there are pieces of coca leaves," said Ruth Salas, an archaeologist from Peru's Museum for Andean Sanctuaries, where the Ice Maiden is kept. These leaves, sacred to the Inca, must have been placed beneath her nose right after she died. We removed the man's tunic draped over her side, wrapped her in cotton cloth, then plastic, and placed her in the freezer with hardly a word.

As the work on the summit continued, our fingertips became raw, and for weeks afterward it was painful even to tie shoelaces. Most days the wind began rising around noon. Constanza Ceruti and Jimmy Bouroncle, one of the Peruvians, were in charge of keeping notes, and more than once I saw them grabbing at wind-lashed pages. At times the windchill temperature dropped to minus 35°F, and even the indefatigable Arcadio was forced to quit early.

The conditions only increased my respect for what the Inca had accomplished—not only digging the graves but actually building structures more than four miles up, using stones found at the summit. Near the tombs, we excavated a two-room stone building in the lee of a volcanic outcrop; it must have

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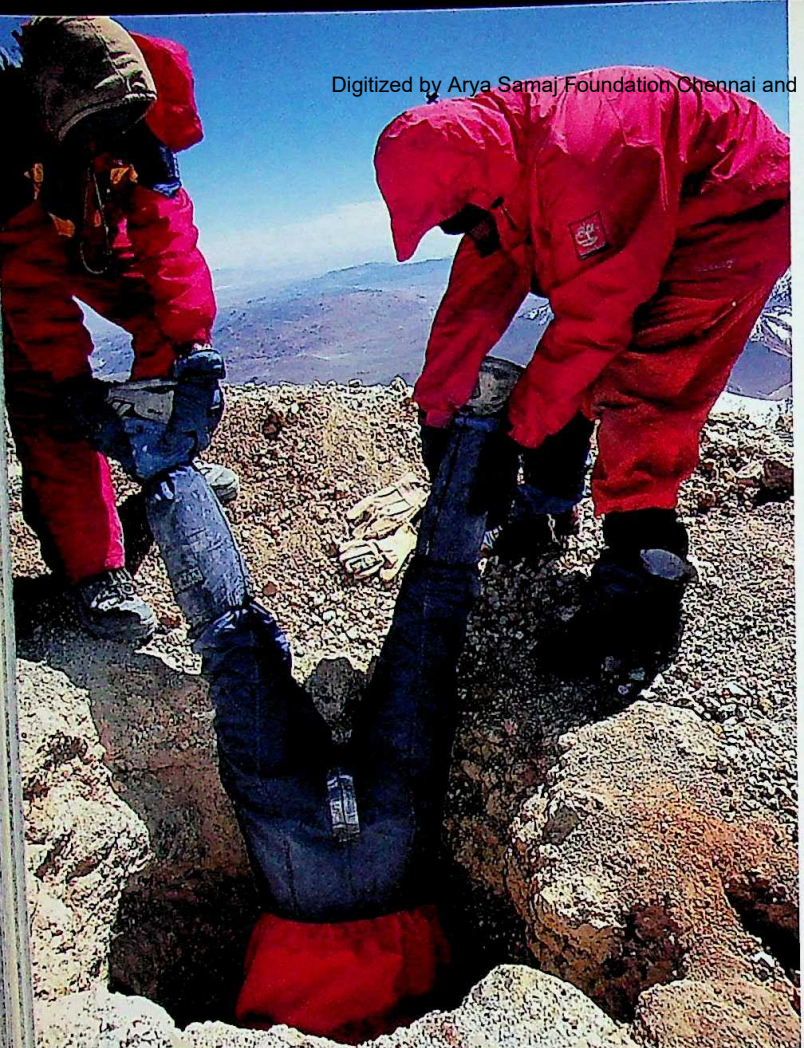

JOHAN REINHARD

provided shelter for the priests who conducted the sacrifices. Inside were grass mats—insulation for sleeping on the cold floor. We found llama dung above 21,000 feet, suggesting that the Inca used these pack animals to carry up some building materials, such as wooden beams, as well as jars of water and *chicha* (corn beer), food, statues, and other ritual objects.

The Inca made good use of the bedrock on the summit, placing the bodies and ceremonial offerings in natural niches they had cleared as deep as ten feet. Excavating one such hole, Orlando Jaen, a Peruvian archaeology student, had to perform gymnastic contortions as he dug deeper. "This is unbelievable," he shouted, and we all converged to see that he had found a row of multicolored feather headdresses—four female statues buried in a single line. More digging led to a telltale bundle. To our dismay, the outer covering was charred: The mummy had been struck by a lightning bolt that had penetrated more

Her feet were

than four feet into the ground.

Once we'd removed and measured the statues, we debated how best to extract the body from the narrow hole. I decided that the safest alternative—at least for the mummy—was to lower Orlando into the hole by his ankles. When we pulled him out, he would be able to prevent the bundle from scraping against the sides. In short order he was lying on the ground, gasping for breath, with the mummy at his side.

As I examined the area where the outer cloth had been burned, the odor of charred flesh was still strong. Silver shawl pins securing the garment was a sure sign that the child was a girl. Unexpectedly, the cloth was loose, and as I drew it back, I was stunned to be staring directly into the face of a girl perhaps eight years old. After I got over the initial shock, I had mixed feelings. I was saddened by her expression, a look that still seemed expectant, yet I was pleased that the lightning hadn't destroyed her. The girl's left ear, shoulder, and part of her chest were badly charred, which made it seem all the more remarkable that the rest of her frozen body was still in excellent condition.

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...were ...icked into her clothes, as if she'd been cold.

Diving headlong into the dig, archaeology student Orlando Jaen is lowered to retrieve one of the mummies from an especially tight spot (left). The young girl had been hit by lightning and partly burned, but the team is amazed by the preservation of her face (center). Snow and insulating foam (right) keep the mummies from thawing before trucks with dry ice arrive to take them back to the city of Salta.

AMONG THE INCA, human sacrifices were rare and were intended as special offerings to the gods. Children were considered purer than adults; indeed a sacrificed child was believed to have been so honored as to have in effect become deified—a direct representative of the people, living with the gods forever after. Such children would themselves be worshiped from afar.

On Llullaillaco the sacrifices probably took place in December, during the South American summer, when temperatures were higher and there was less snow. The closest Inca administrative center of any importance was at Catarpe, near present-day San Pedro de Atacama, some 120 miles to the north in Chile. But the styles of the textiles, statues, and pottery indicate that they originated in Cuzco, Peru, about a thousand miles to the north. People living near Llullaillaco must have believed the mountains controlled weather as well as the fertility of animals and abundance of crops in the region—which is why people still worship the mountains today. The Inca authorities in Cuzco—the seat of the empire—knew that making offerings on sacred mountains was a way to incorporate those deities into the state religion, giving themselves greater control over the outlying people they subjugated.

Accounts written after the Spanish conquest describe months-long pilgrimages and even name the sacrificial children. In some cases a child was offered by his parents, who may have accompanied him on the journey. Local people would also assist the priests in ceremonies, perhaps with religious dances and drinking, until the procession reached its destination.

More ceremonies would have attended the long climb to the summit, which may have taken three days. Inca sacrifices reportedly died by being buried alive, by strangulation, or by a blow to the head—which is how the Ice Maiden died. The Llullaillaco children, however, have benign expressions and bear no obvious physical scars, suggesting that they died while unconscious or semiconscious, probably stupefied by a combination of ritual alcoholic drinks and altitude.

After two weeks on the summit the altitude was wearing us down, and provisions were running low, but we had accomplished everything I'd hoped to do. After we had filled in the

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Chosen One

She still smells of charred flesh from the lightning strike that marred her ear, shoulder, and chest, but the rest of the young girl's body is in excellent condition. "A special blessing," says archaeologist Constanza Ceruti, the expedition's deputy director, because the strike loosened the textiles and made it possible to see the girl's face on the summit. Though her organs are undamaged, the lightning exposed deep tissues, making sampling easier.

Extracting the two dozen artifacts found near the body was tough work in the cramped grave; the position of each piece had to be meticulously recorded. "Digging takes a titanic effort, but even taking notes is hard at 22,000 feet," Ceruti says. "But it's important because for the Inca there was a lot of symbolism in the way they arranged offerings."

Among the artifacts were statues, pottery, food bags, and this coca bag made with feathers, perhaps from Amazonian birds. Coca was sacred for the Inca, and Andean people still use it regularly in offerings.

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last of the excavations and gathered our tools, the wind dropped, and the Andes treated us to one of the most beautiful sunsets imaginable. I had arranged for dry ice to be brought to the mountain base to keep the mummies frozen on the two-day trip to Catholic University. There, Juan Carlos Romero, the governor of Salta Province, and Antonio Lovaglio, the minister of education and culture, made sure that we had the necessary materials to preserve the mummies in a temporary laboratory.

FULL ANALYSIS of the bodies and the textiles and artifacts associated with them will take years, but some findings are already in. CT scans of the bodies showed that their organs are nearly perfect. They also appear to have a large quantity of blood frozen in them, which is likely a first. "It opens up a whole new window of research," says Arthur Aufderheide of the University of Minnesota School of Medicine in Duluth. "We can search for antibodies that would indicate which diseases infected the children." By teaching us how some diseases have developed over the centuries, this knowledge may even help combat diseases today.

To test the children's DNA, we took tissue samples by needle biopsies. "The mitochondrial DNA couldn't be better," says Keith McKenney of the Institute for Biosciences at George Mason University in Virginia. "What we know for now is that they were not siblings or closely related on the maternal side." Their mitochondrial DNA sequences make it possible to identify modern-day relatives.

When I examined the younger girl, whose face and charred shoulder had become engraved in my mind, I saw details I'd missed in the emotional moments on the summit. Two braids were parted on either side of her face. Her mouth was slightly open, exposing her teeth, and her hands and feet were tucked into her clothes, as if she had been cold. Along with the two other children sacrificed on Llullaillaco, this gentle Inca girl has given us a rare opportunity to deepen our understanding of the lives and times of her people. Scientists from numerous fields have yet to begin their studies, and eventually I hope to report again on these extraordinary discoveries.

For an online Andes expedition with Johan Reinhard go to *www.nationalgeographic.com/andes.*

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Inca Key

For the Inca, textiles were a highly prized art, an honorable gift, and an essential element of sacrifices. This tunic, found draped over the older girl's shoulder, took months to make. An interlocked tapestry with a design called Inca key, the tunic was worn only by nobility and was likely intended as a gift for the mountain deities. One of the best preserved of its kind, the tunic is cleaned by conservators in Salta with delicate brushes, tweezers, and vacuums (below).

With no written language, the Inca used textiles to record information. Clothing revealed where people were from and where they stood in society. Unfortunately the elaborate codes contained in the patterns may never be fully understood.

Artifacts of Empire

The author's newest discovery increased by half the world's known collection of clothed Inca statues. Twenty clothed and 16 unclothed statues were found, plus dozens of other artifacts. The costumed statue at right, probably made in Cuzco, is identical to ones found in other parts of the continent. "I'm always stunned by the Inca Empire's vast reach," says Inca textile expert William Conklin. "One rarely finds anything in the world of archaeology that is stamped out from one site like that."

The sandals above, found with the boy, may not have been Inca-made and might someday shed light on his origins. The rope sling was used with rocks for hunting and fighting. The pot below may contain food or *chicha* (corn beer). Eventually the stopper will be removed and the contents examined

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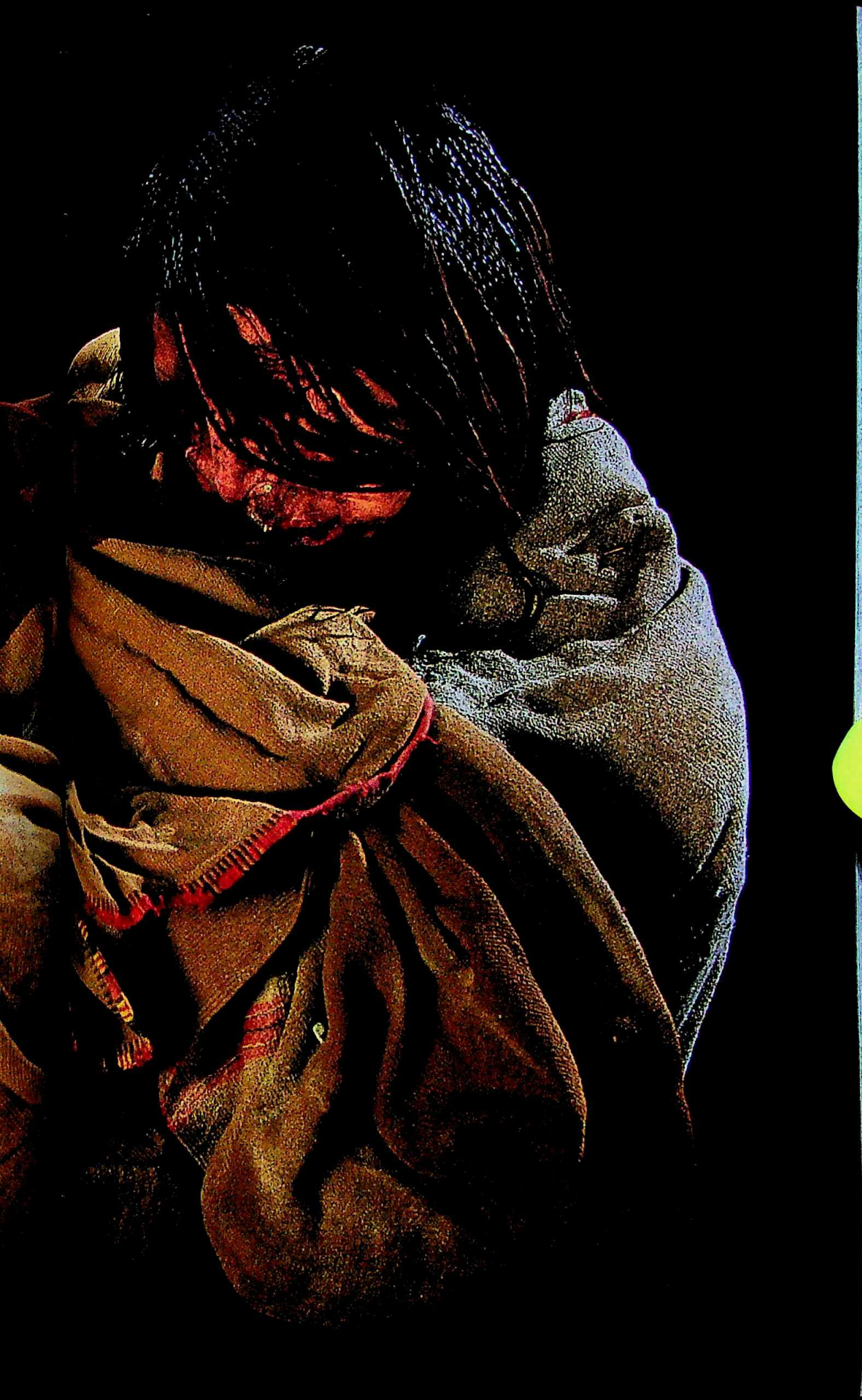
Go Gently

Faces of the dead can hold grimaces of pain, but the teenage girl wears a placid expression. Before death, all three children were probably unconscious from a combination of altitude and chicha—part of the plan, it seems, to send them into the next world undistressed. The children died expecting immortality, and in a sense they got it: With their organs and blood frozen in place, their DNA has survived unscathed and may point scientists to their present-day relatives. □



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Preparing to sail solo, Panamanians will assume full responsibility for their famed canal at noon on December 31, 1999. After 85 years of United States stewardship, the *yanquis* are finally going home.

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Panama's Rite of Passage

BY LEWIS M. SIMONS
PHOTOGRAPHS BY ALEX WEBB

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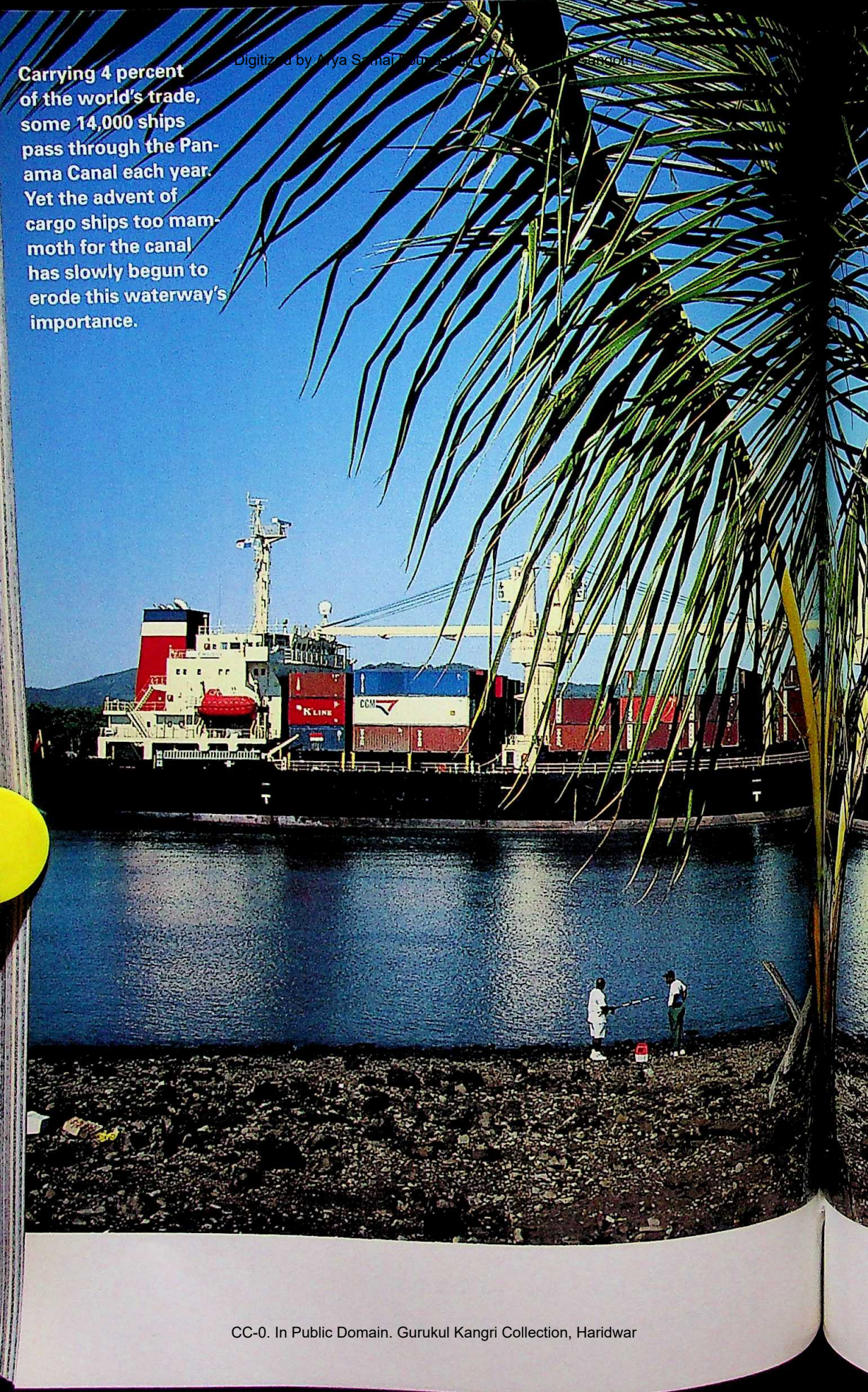

Carrying 4 percent of the world's trade, some 14,000 ships pass through the Panama Canal each year. Yet the advent of cargo ships too mammoth for the canal has slowly begun to erode this waterway's importance.

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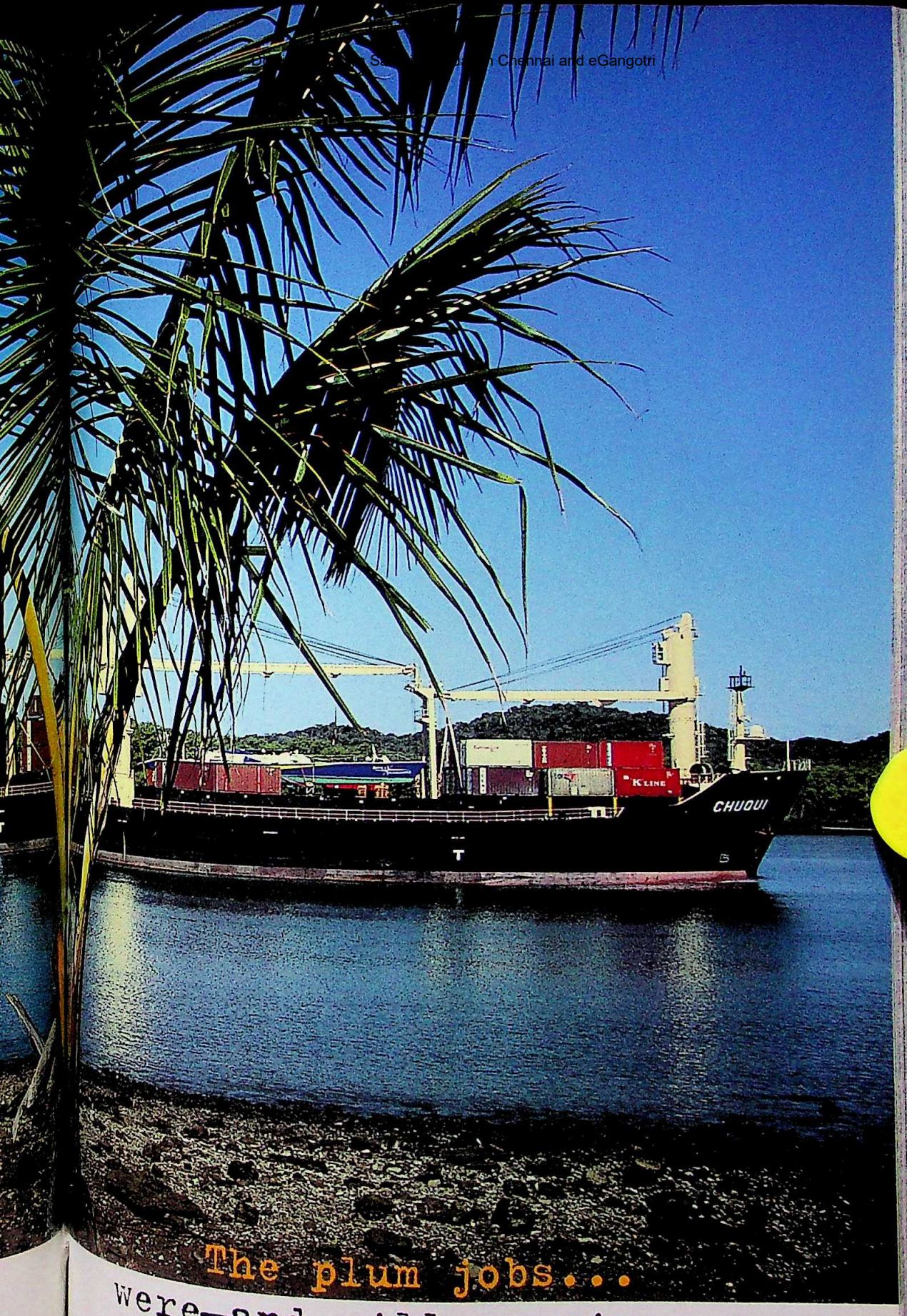

The plum jobs...

were—and will remain—
on the canal itself.

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Sacking out till the next customer arrives, a vendor at the Ancón fruit and vegetable market takes an impromptu siesta. "But there's no real siesta in Panama City now," says one native. "To be competitive, you gotta keep going."

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People here have never
learned to
feel independent.

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The first two fingers of his right hand wrapped tight in a thin cotton rag, Alfonso Gonzalez Sanchez works the wax in tiny overlapping circles, coaxing the toe of the black leather combat boot he holds across his knees to a brilliant gloss. From time to time he dips the cloth into an old polish tin of water: the technique of the classic military spit shine. Around him, as he sits in the shade cast by a precise column of royal palms, are arrayed the 23 pairs of identical boots that are the day's work ahead. Some are caked with dried mud and will require a thorough scrubbing before he can begin rubbing them to inspection standard.

There is harder, dirtier work, certainly, but polishing the boots of foreign soldiers occupying your country is not something most of us willingly would choose to do. Yet Gonzalez is delighted to have this job, serving the officers and men of Building 127, Theater Support Brigade, Fort Clayton, Panama, U.S. Army South. But he's also sick with worry, knowing that come the end of the year, they'll leave and with them his livelihood of 21 years.

Gonzalez is 55 years old and lives in a small wooden house with his wife, their seven children, and her stepfather. No longer up to heavy lifting, he sees no future other than rolling a pushcart out into the narrow streets of Casco Viejo, the old quarter of Panama City, trying to sell inexpensive items to passersby: dish towels, maybe razor blades, hair ornaments—or shoelaces. No matter what new occupation he undertakes, he knows that nothing will pay nearly as well as boot polishing for the GIs. At Fort Clayton he earns between $250 and $300 a month for helping the soldiers look sharp. As a onetime net hauler aboard a shrimp boat, he knows that manual laborers in Panama are lucky to get six or seven dollars a day, less than half what the Americans pay him.

"Every day I pray to God that the gringo doesn't leave," Gonzalez tells me as he takes a short break, wiping sweat from his forehead with the back of a polish-blackened hand. "All my life I thought the Americans would never go. And until I see them get on their airplane and fly away, I'll continue to believe this." Then he glances down at his own shoes, once white sneakers, the backs squashed flat for ease of entry and egress. He shakes his head slowly, grudgingly acknowledging the reality: "It's very bad for our country that they're going; the biggest mistake Panama has ever made."

LEWIS M. SIMONS is an award-winning foreign correspondent whose work over 30 years has spanned the Asian continent. This was his first assignment in Latin America. Photographer ALEX WEBB, who has worked extensively in the region, contributed to our special issue on Mexico in August 1996.

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Want to do business in Panama City? Club membership can help seal a deal. At Club Ejecutivo, a golf and social club that hosts the occasional wedding reception (left), you'll find entrepreneurs, merchants, the newer money. Old, established families congregate at Club Union, while boating enthusiasts head to the Club de Yates y Pesca (above, at bottom left). Class and racial divisions persist among the city's many clubs, as they do in much of the world.

At noon on the final day of 1999 the United States will ceremonially hand the government of Panama the monumental canal, which was created by American ingenuity (U.S. engineers commanded nearly 75,000 workers from around the world in the ten years of construction), fortune (387 million dollars), grit, sweat—and connivance—at the outset of a century Americans now claim as their own. The last of some 7,000 U.S. military and civilian buildings in the former Panama Canal Zone, a ten-mile-wide strip of land bracketing the waterway along its entire 50-mile length, also will be turned over. And the last American soldier will leave.

At the peak during World War II the U.S. had 60,000 troops in Panama. Even a decade ago 11,000 U.S. soldiers were stationed there, and the military pumped 350 million dollars into the country's economy each year. The U.S. forces directly employed 2,800 local civilians in a variety of jobs, ranging from clerks to plumbers. Since the "zone" was always run as an outpost of the U.S., Panamanians who got these prized jobs were paid almost at U.S. levels. This created anomalies: Bookkeepers for the U.S. Army earned as much as executives in Panamanian corporations, clerks as much as doctors. The plum jobs, however, were—and will remain—on the canal itself, and by the end of this year the 9,000-member workforce will be almost entirely Panamanian.

Alfonso Gonzalez isn't alone in wishing the full U.S. presence would continue, or in his gloomy outlook. As many as 78 percent of the country's 2.8 million people, according to a 1996 poll, hope the gringos won't go. And like Gonzalez, they anticipate bleak times ahead as the final phase of treaties worked out between Panama and the U.S. in 1977 kicks in. Those

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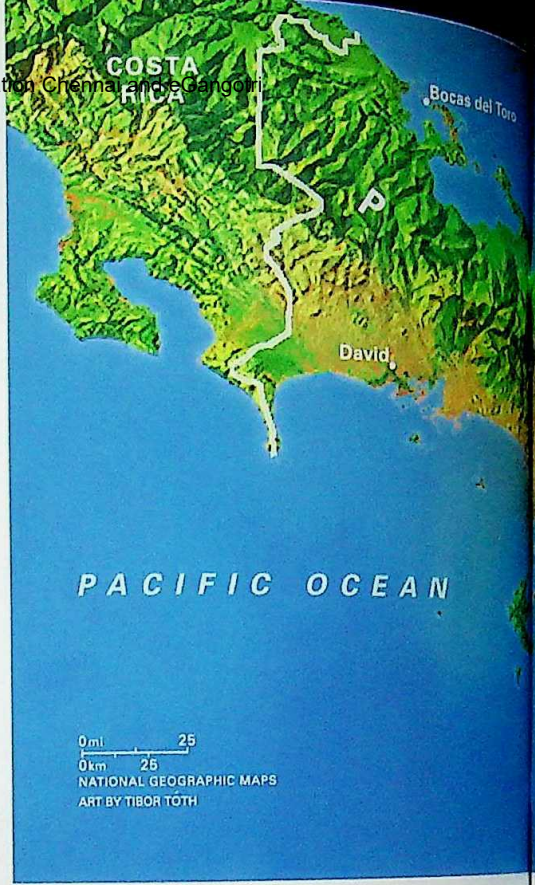
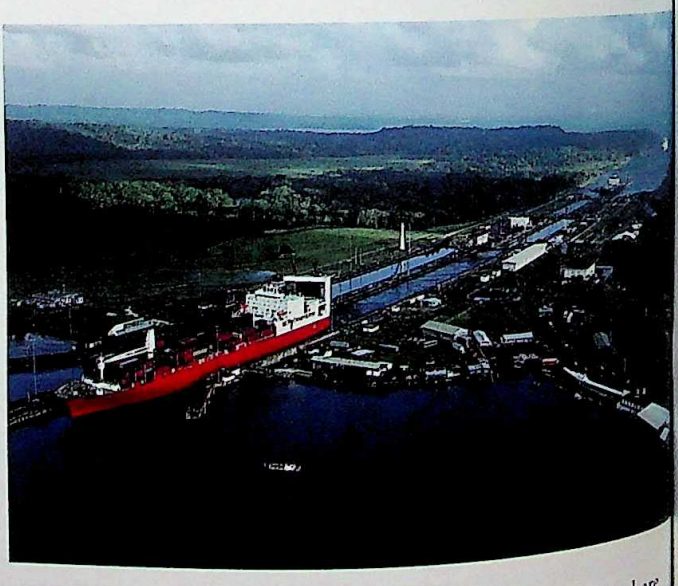
agreements, negotiated by then presidents Jimmy Carter and Omar Torrijos, resulted in the shutting down of the U.S. military apparatus and the controversial "reflagging" of the canal from the United States to Panama.

Although Panama has existed as a country since 1903, the U.S. involvement has been so overwhelming that people here have never learned to feel independent. Now, for the first time since Theodore Roosevelt used gunboat diplomacy to wrest the Isthmus of Panama from Colombia and create a special-purpose state where the United States could build and run the canal, Panamanians are on their own.

"We're like the little boy in short pants who's always run to daddy when he's gotten into trouble," said Roberto Brenes, an economist and banker in Panama City. "Now, daddy's gone, and the little boy must put on his first pair of long trousers."

Naturally, not everyone will miss the Americans. At a demonstration near the University of Panama, protesting a government plan to turn Panama City's water department over to private management, a graduate student in biology buttonholed me. "It's long past due that your country leaves us alone. Colonialism is out of fashion, you know."





Of all the uncertainties ahead, the one most on people's minds is what will happen to the canal and the facilities in the Canal Zone. Although of little military use today, the canal is still vital to international shipping, cutting the distance between, say, Tokyo and London by 4,500 miles. Every year 14,000 ships pass through it, carrying more than 4 percent of the world's trade.

At the granite, colonial-era administration building above Balboa, on a tree-covered hilltop at the Pacific end of the waterway, I called on Alberto Aleman Zubieta, the canal's third Panamanian administrator. Youthful and casual, Aleman suggested that when it comes to the day-to-day running of the canal, Panamanians have already overcome their dependence on the U.S. We spoke in the airy, mahogany-furnished office that goes with the top job, its sea green walls lined with historic oils of the waterway and its ships. "Jobs on the canal are highly prized in our society," he said. "By filling every position with only the most qualified people, we're assuring a seamless transition from a U.S. to a Panamanian canal."

For a look at how the transition was going, well before dawn one morning I drove an hour and a half from Panama City to the northern end of Gatún Lake, at the approach to one of the canal's three sets of locks. When filled with or emptied of water—52 million gallons each

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If building the Panama Canal was a Herculean feat, its impact on trade was equally Olympian. Once the U.S. opened the Big Ditch in 1914, ships sailing from New York to San Francisco could chop 9,000 miles off the journey by using the canal (left) instead of rounding South America. The big job these days is managerial. Some observers fear that the Panamanian government will use canal revenues for pet projects instead of keeping the waterway shipshape.

enough to meet the daily needs of a city the size of Detroit—these mammoth concrete-and-steel boxes raise and lower ships 85 feet to cross the Continental Divide.

The rising sun brought an instant steam bath, but canal workers seemed impervious, neatly dressed and attentive to their duties. The more-or-less natural surroundings of the man-made lake, with its jungled shores and tiny green islets—in fact, flooded hilltops—give way to the locks' concrete walls, topped by stubby, powerful electric locomotives that guide the ships through the passageways.

At Gatún Locks I was taken out into the navigation channel by motor launch to a rust-streaked blue-and-white car carrier, the *Southern Ace,* owned by Japan's Mitsui Corporation. There was nothing graceful, or even shiplike, about *Southern Ace.* More than 620 feet long and as high as a five-story building, it was simply a floating parking lot capable of hauling nearly 6,000 automobiles. On this voyage, from Bremerhaven to Los Angeles, *Southern Ace* was carrying 1,288 Mercedes-Benzes and Volkswagens. A fragile-looking Jacob's ladder of wooden slats linked by knotted ropes was dropped over the side, and I climbed it, gingerly, up to the deck.

On the glassed-in bridge I met Edgar Tejada, the pilot who had just brought the ship through the locks and now would guide it across Gatún Lake and through the Miraflores and Pedro Miguel Locks to the Pacific. Tejada, 45, has been a pilot—the elite of the Panama Canal workforce—since 1984. Before that he was the master of a canal-going tug. He performs his task pretty much as it's been done since the first ship, the *Ancón,* crossed from the Atlantic to the Pacific in August 1914: by

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Playing devil's advocate, kids show off their masks in Colón's La Playita neighborhood a few days before Carnival. In this slum, riddled with unemployment, drugs, and crime, the devil gets his due the rest of the year too.

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Sangoti

Nothing will pay...

as well as boot polishing for the GIs.

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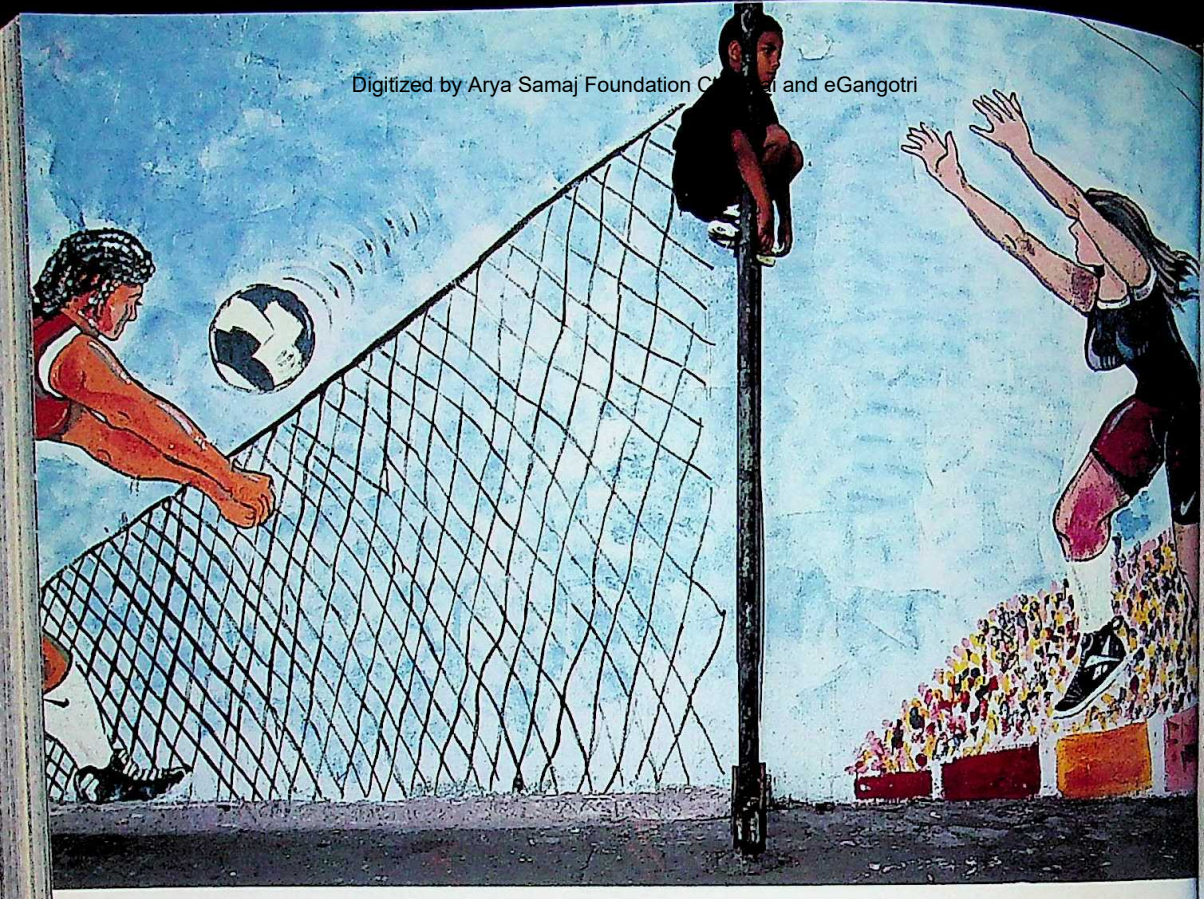

Larger than life, a mural in Panama City reflects a small part of the cultural legacy of the United States, where volleyball first got rolling. Another U.S. legacy is the huge inventory of military facilities, including an old radar station on Semaphor Hill (right). Once used to help intercept planes carrying drug smugglers from South America, the building was recently converted into the Canopy Tower—a rain forest roost for birders and other ecotourists.

eyeball, feel, and instinct as well as experience.

"The canal is so short, with great variables in tides on the Pacific side and with so many narrow twists and turns, such sudden changes in weather and wind, that if I look away for even three seconds, we could be out of the channel and on a sandbar," Tejada said. For their expertise, Panama Canal pilots are paid $80,000 to $150,000 a year, comparable to airline pilots in the U.S.

Seated at barstool level, peering through well-worn binoculars, Tejada ordered the young Filipino navigator to proceed at ten knots. Approaching a bend, he called "one-two-three," and the navigator turned the ship to 123 degrees on the wall-mounted gyrocompass. In ragged succession, ships passed us heading in the opposite direction. The swell and suction created between ships occasionally causes a foul-up. Only a week earlier, Tejada said, a container ship had run aground near where we were, costing its owners six days of downtime while it was refloated.

As we cleared Gaillard Cut, a landslide-prone strip notorious for breaking spirits during what the Americans called simply "the work," a shrill whistle sounded in the distance, and the air reverberated with the blast of dynamite. Perhaps no other place along the canal so graphically illustrates the struggle between the men who dug it and the land they were taming. The cut runs for more than eight miles through rock and shale, the very core of the Continental Divide. What you don't see as you cruise past its black, steeply sloped wall is the 48-foot depth beneath the surface of the water. Again and again as this channel was dug, earth slides buried men and machines, stalling progress.

Now the Gaillard Cut is being broadened and deepened as part of a one-billion-dollar

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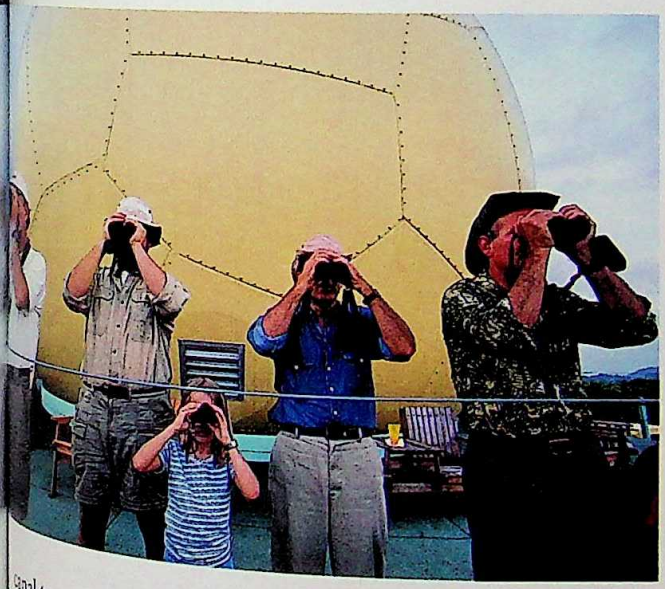
improvement on the eve of the handover. These improvements will clear a canal bottleneck, enabling two-way traffic for larger vessels within the cut for the first time.

"We've always dreamed of having everything under our flag," said Tejada. "Now we'll have to do everything right, and that will help the national spirit." He broke off our conversation to call a new direction to the navigator. But his burst of patriotic optimism was at odds with the worries so many others had expressed.

A nervous start is understandable, according to Ambler Moss, a former U.S. ambassador to Panama and now the director of the North-South Center at the University of Miami in Coral Gables. "Too many things are happening at once—they're taking charge of the canal; they're trying to convert the bases; the troops are leaving; they're getting a new president. But," he said, "Panama has less reason to worry than the Philippines did. It's close to the U.S. The U.S. needs the canal. Other countries, especially in Europe and Asia, need the canal too, and they want to invest."



Meanwhile Panamanians are putting their stamp on the canal and its surroundings. Some of the buildings that used to house American civilian and military personnel in tropical suburban comfort have already been sold to local families. They're moving in, adding decorative touches like faux pillars, religious statuary, and shadows, greens, and hot Caribbean pinks over the government-issue white walls.

Albrook Air Force Base is now Panama City's domestic airport, and work is under way on a number of other ambitious projects. At Fort Espinar, near the Caribbean end of the canal, the once infamous School of the Americas—where, judging by Defense Department training manuals, U.S. experts tutored a generation of Latin American dictators in the arts of torture, interrogation, and other necessities of retaining power—is being rebuilt as a luxury hotel and conference center. Fort Clayton, with its rolling lawns and red-tile-roofed buildings, will become an education and technology center called the City of Knowledge.

Back on the bridge of the *Southern Ace,* Tejada and I resumed our discussion, but the direction of his thoughts had shifted. "In theory the new national law adopted by the government to operate the canal totally isolates it from politics. But in Panama the politicians always have a way of misconstruing laws so that they work out to someone's personal benefit. That's the problem in Panama."

Like Tejada, some Panamanians anticipate that once the handover is completed and the Americans have gone home, politicians will dip into the lucrative canal as if it were their private piñata, loaded with goodies. A leading critic is Maylin Correa, the outspoken and popular mayor of Panama City from 1991 until early this year. Over lunch at her spacious but simply furnished office in City Hall, a grime-encrusted building at the edge of the capital's old quarter, she claimed that while 5,000 jobs are being lost, the national government "is putting Panama up for sale." What Correa meant was that assets from the canal were already being siphoned off to those close to the outgoing president, Ernesto Pérez Balladares. "The people are not benefiting," she said.

Balladares, whose term ended in August, was reviled in the local press, particularly the widely read *La Prensa,* as well as by his political opponents, for appointing relatives and friends to the canal board of directors. In a lengthy conversation while he was making an

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out-of-town helicopter trip, he laughed dismissively when I asked him about the claims. "I've chosen those with the best capabilities, and I'd choose the same ones all over again."

The new president is Mireya Moscoso, widow of Arnulfo Arias—three times elected president and three times overthrown by the army—and the first woman to lead Panama. On the eve of her victory in May, Moscoso promised to replace Balladares's appointees as soon as their terms expire, some next year. "We need to tell the world we are prepared to manage the canal as well as the United States," she said.

Certainly the workers who run the canal are doing things well. As the *Southern Ace* steamed toward the Pedro Miguel Locks—where there's a red-and-blue billboard with the words "Providing Passage Into the 21st Century"—a launch approached, and a team of line handlers boarded. They had the tricky task of throwing well-aimed ropes to the locomotives, which steadied us into the lock with cables. The exquisitely balanced gates swung shut behind us, and gravity went to work, flushing water out and lowering us 30 feet. So controlled was the operation that the only awareness I had of changing levels came from watching the watermarks on the gray concrete walls of the lock. Out of Pedro Miguel, we proceeded again at a stately pace.

At Miraflores Locks, rather than continuing for the rest of the 14-hour transit, I clambered back down the ladder to a launch and waved good-bye to Edgar Tejada. His skill in directing

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Grab a chair in the dining room of the Canopy Tower, 40 feet above the rain forest floor, dig into dinner, and enjoy the wild show outside—white-faced capuchins and howler monkeys, black-breasted puffbirds, keel-billed toucans. "I love nature, and here I'm completely surrounded by it," says owner Raúl Arias de Para, who calls the former radar station "the ultimate recycled product."

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…*Southern Ace* seemed to confirm former …mbassador Moss's optimism. It struck me …hat the transformation to self-reliance may …epend less on Panamanians acquiring exper… than on their ability to stop thinking of …emselves only as little brothers—of America …the past century, of Colombia before that, …d, earlier still, of Spain.

EVER SINCE the Isthmus of Panama became a stone-paved pathway for gold- and silver-laden Spanish mule trains five centuries ago, the region has attracted people on the make. Today Panama City's shoreline prickles with tinted-glass towers housing 104 international banks. They're here in part because of loose banking rules, which allow Latin American drug traffickers to launder their millions, but also because Panama's currency is the U.S. dollar (and will remain so), which helps protect the economy from high rates of inflation.

If Panama has drawn more than its share of adventurers, pirates, con artists, and other scalawags, this same dubious distinction has made it one of the most cosmopolitan centers in the world. Large numbers of Chinese and Indians, Arabs and Jews, Europeans and West Indians have come in, some legally, others not, set up shop, and assimilated to one degree or another.

But even in Panama there are limits to tolerance. Some of the wealthiest white families, most of whom are of Spanish heritage and nearly all of whom are members of the plush and exclusionary Club Union, built into the bayside a few blocks from the new synagogue, do not welcome the dark-skinned, the Muslim, or, with a few exceptions, the Jewish, however wealthy they might be. Inordinately proud of their fair complexions, these Panamanians are called, with a mixture of envy and derision, *rabiblancos,* white tails.

On Super Bowl Sunday I joined a standing-room-only crowd of them (plus a handful of resident gringos) at Bennigan's, the trendiest spot in town. Some of the Panamanians actually watched the game, but most were making the rounds, air kissing and drinking Budweiser. When I asked a statuesque blonde in breath-takingly tight jeans and T-shirt why there were no blacks in the crowd, she immediately countered, in unaccented English, "Would it be any different in Miami or L.A.?"

Life for the rabiblancos includes weekend shopping jaunts to Miami, second homes in Boca Raton, and kids jetting off to Notre Dame and Boston College. In all likelihood it does not include visiting Darién Province, Panama's poorest region, on the border with Colombia just a few hours' drive from Panama City.

Nor, until recently, did the government pay much attention to Darién, which has no more than 50,000 small farmers and indigenous people. As a result Colombian guerrillas fighting the government in their country, as well as cocaine "mules" and other Colombian outlaws, have taken to slipping across the unguarded border and using Darién as a refuge and a place from which to steal food, cash, and weapons.

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Run-down bayside real estate in Panama City's El Terraplén section will soon feature cafés, boutiques, latte shops, and the like. It's a bright bit of urban renewal in a nation where nearly 40 percent of the people live below the poverty line.

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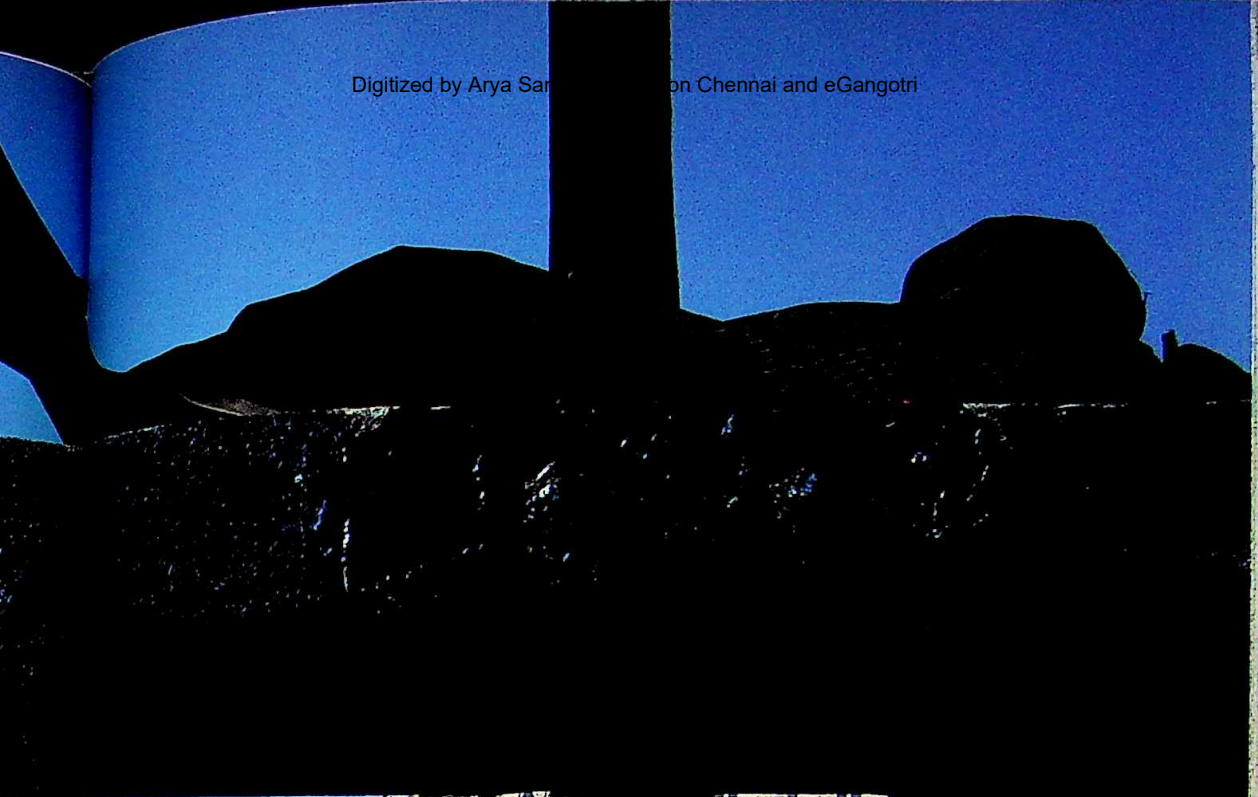

"I'm afraid there's going to be a lot of unemployment."

—ARACELYS BETHANCOURT, PANAMA CITY

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Occasionally the Colombians make armed attacks on villages. In 1997 they killed two civilians and a policeman, wounded two other policemen, and kidnapped a civilian in the riverside town of Boca de Cupe.

"It has always been a marginal zone, very poor, and this has created an environment for crime and unrest," said Clovis Sinistera, the province's U.S.- and French-trained police commissioner. I met him in Metetí, the sleepy provincial seat in central Darién. "We're trying to hold the peace in a difficult situation, in which the Colombian government has problems with thugs and guerrillas, and they spill over here."

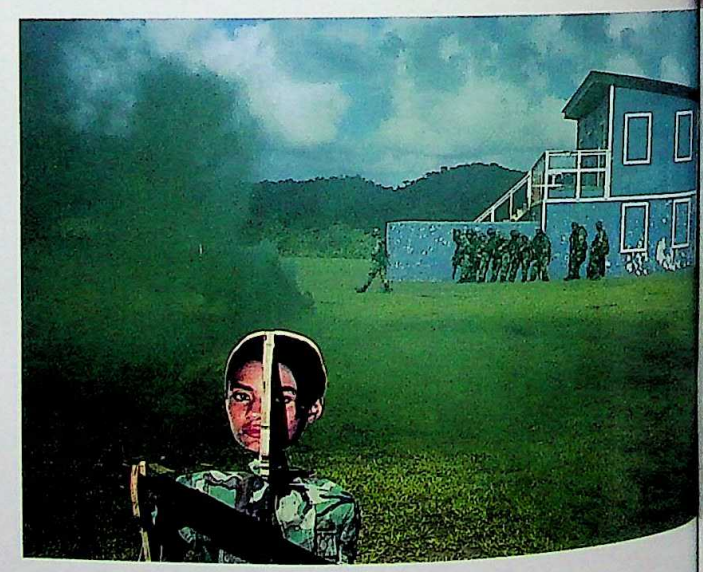
People in Metetí, and practically everywhere else I traveled in the country, share the anxiety that once the U.S. military presence is removed, Panama—which has a 16,000-member police force but no longer an army of its own—will be even more vulnerable to Colombian drug runners and insurgents.

Monsignor Romulo Emiliani, the Catholic bishop of Darién, takes the province's security as a personal challenge. Following a drum-thumping, hand-clapping folkloric Mass at his simple concrete-block church in Metetí one Sunday, Emiliani—a hearty, ruddy-faced man of 50 with a boisterous laugh—told me that in the past year increased financing by the central government and tougher training have produced "acceptable" police control in the area. Darién, he said, was in a watch-and-wait mode. "We need more and better police security to take care of a Panama without the U.S. If not, Panama will never become a truly sovereign country."

With a small group in a pencil-thin pirogue, I made a journey up the Tuira River into the heart of Darién. We started from the town of El Real, ringed by jungle, where there were signs of stepped-up security. Lt. Roberto Lewis, the ranking police officer, was supervising a dozen men uniformed in black shorts and T-shirts, sweat-soaked in the spongy heat, as they unloaded concrete blocks from a barge. They were to be sent on a smaller boat to Boca de Cupe, to build a police station. "This will help expand our network, which used to stop at El Real," Lewis said.

Francisco Mepaquito, our stocky Wounaan helmsman and guide, carved slalom-like turns through the shallow, winding Tuira. With us was Tonny Membora, also a Wounaan, who was on a buying trip for the exquisitely handcrafted baskets he sells in Panama City.

In Darién the 2,000 Wounaan, along with the 12,000 members of the Emberá group, are the surviving descendants of Amerindian peoples decimated by the conquistadores. Of late, the two native minorities have begun trying to overcome cultural differences in hopes of gaining some of the political clout of the more numerous Cuna, concentrated in the San Blas Islands. Panama's other indigenous people, the Ngobe-Bugle, scrape by picking coffee beans in the hills along the Panama-Costa Rica frontier.



After three hours we reached Boca de Cupe, a village of 900 people, mainly descendants of African slaves who escaped the Spanish conquistadores. The village was guarded by 35 policemen wearing camouflage and dug into sandbagged bunkers protected by Czech-made machine guns. Their officer, Lt. Oscar Eraso, said that when the new police station is built, there will be a hundred men here. A few weeks before I arrived, he said, nearly 150 Colombian guerrillas had taken over a nearby village, remaining there for about ten days before going

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Armed for a bath: Thousands of border policemen, including this patrol heading to a river in Boca de Cupe, were recently dispatched to Darién Province to help deter violent incursions by leftist guerrillas from neighboring Colombia. At Fort Sherman, soldiers sweat at what was the U.S. military's only jungle warfare training facility (left). Since the fort reverted to Panamanian control, Pentagon officials have sought a suitable replacement, in vain.

back across the border. "This area is convenient for them, and they were just resting, not causing any trouble. We didn't attack—generally we don't—because if they knew we knew they were there, they would kill our informer."

Eraso, tall and broad-shouldered, had made friends among the people in the isolated village under his protection. We bought orange sodas at a tiny store owned by Aleida Ramos, whose husband, Antonio, had been kidnapped by Colombians in August 1996. They held him for some months, until she was able to raise the $50,000 ransom from her extended family and the rest of the village, where the average annual income is about $80. "Things are better now," said Mrs. Ramos, as she rocked in a straight-backed chair on her shop's front porch. "But I'm still afraid of the guerrillas. You never know when they may come back and kidnap you, or worse."

We left Boca de Cupe and motored a few more miles upriver to the Wounaan village of Capetuira—Francisco's home—where we spent the night. Like Boca de Cupe and most other riverside settlements Capetuira was guarded by heavily armed police holed up in a hillside bunker with clear views of the large, open-sided huts and the river beyond. The government had recently brought electricity to the town and put in two concrete sidewalks, but there was no avoiding the poverty.

In the morning I climbed a notched log to Francisco's stilt house. His four-year-old daughter, Gricelda, was sitting on the springy, split-bamboo floor. When I held out my arms to her, she burst into loud wailing. Francisco scooped her up, explaining that Gricelda had been born with twisted legs and couldn't walk or crawl. Visiting paramedics lacked the knowledge to help, and the family couldn't

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Matadors for a minute or two, spectators at a fair in Tambo are invited to put down their drinks and jump into the ring. The bulls here aren't bred for fighting, but during these days of transition in Panama, flexibility is an asset.

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"It was a great ride while it lasted."

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—DENISE WILL, CANAL ZONE

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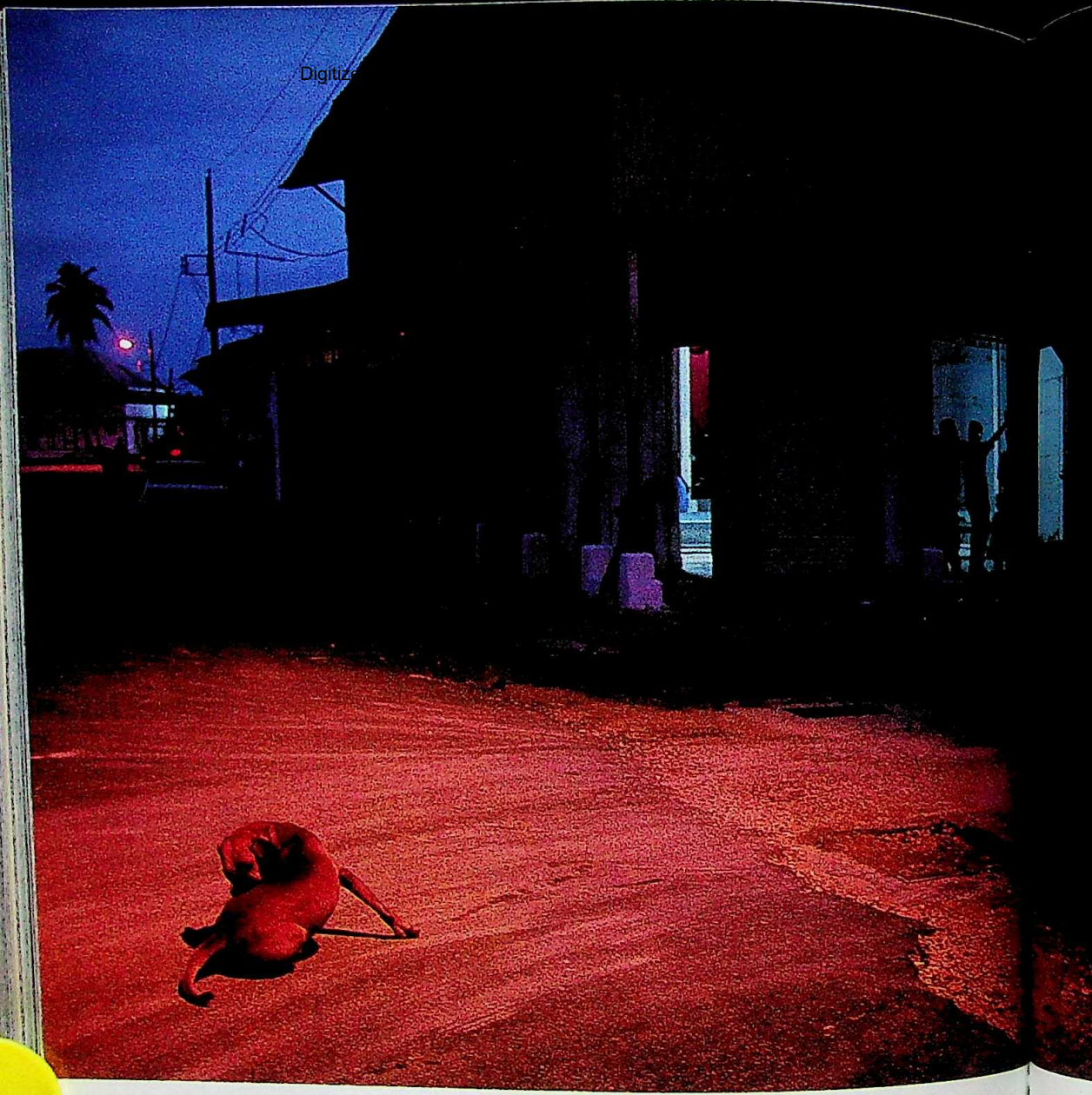

afford to travel to Panama City for qualified medical care.

FOR PEOPLE as poor as Francisco Mepaquito, these twilight days of the American presence bring the worry that they will grow only poorer in the years ahead. The rush of *soberania,* sovereignty fever, that greeted the Torrijos triumph—Panama even named a national park and a beer for the newfound emotion—is long gone.

Back in Panama City I wandered along Calle 27, a street of grimy concrete tenements in El Chorrillo, one of the capital's poorest, most crime-ridden neighborhoods. It was Sunday afternoon, and residents were out in crowds, gossiping, laughing, snacking on fried plantains, drinking beer, betting on televised horse races, flicking their hips to blaring Caribbean tunes. El Chorrillo was ground zero when invading U.S. forces attacked the city just before Christmas 1989, eventually seizing Gen. Manuel Noriega, whose command center was located there. Noriega had been a long-time CIA and DEA anti-narcotics and anti-Marxist informant, but his blatant corruption had become an embarrassment.

When I stopped to speak with a group of women chatting beneath a broad red-and-green-striped umbrella, they were more concerned about the impending departure than bitter about the past. "It's not an easy matter to discuss," said Aracelys Bethancourt, a

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"America is a large, friendly dog in a very small room," historian Arnold Toynbee once observed. "Every time it wags its tail it knocks over a chair." Soon Panama, from Bocas del Toro (left) in the west to the wilds of Darién in the east, will be free of American forces. But a bilateral treaty states that if the canal's security is threatened, the U.S. will return, teeth bared.

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...-year-old mother of two, wearing a red tank ...p and yellow shorts. "Sovereignty is impor-...nt, it's true, because it means we're free to ...press ourselves and to do as we like in our ...wn country. But I don't trust our politicians. ...m afraid there's going to be a lot of unem-...loyment and poverty."

She said that her husband, a housepainter, ...considers himself lucky during weeks in which ...he makes $60. He doesn't receive any social ...security or insurance benefits. To supplement ...his income, Bethancourt sells paper plates of ...fried chicken and beet-dyed potato salad, a ...dollar apiece, from a small table under the ...umbrella. "Most of the men in this neigh-...borhood work for the Americans," Bethan-...court said, "and they earn five dollars or

PANAMA

...even seven dollars an hour plus benefits."

So, while she and her family eke out a life at just above the poverty level, their neighbors doing manual labor on the U.S. payroll have been earning at least four times as much.

Americans in Panama, whether they're in the armed forces or work for the canal, say they, too, regret having to go. Robert Will, 51, was born in the Canal Zone, a third-generation "Zonian." His grandfather was a pilot, his father a tug captain, and he's a tonnage surveyor, assessing ships' weights to determine their tolls. Except for two years in college and a year in Vietnam, Robert has lived all his life in the Canal Zone. His wife, Denise, 43, came from Minneapolis in 1967 with her parents—her father supervised the locks—and she, too, works for the canal, compiling a history of the U.S. presence.

The Wills and their two young children have lived comfortably—and, as do all Zonians, rent free—in a village near Ancón. It's a tidy, all-American neighborhood of white bungalows and town houses on neatly clipped lawns and looks as if it has been lifted out of a South Florida subdivision and set down alongside the canal—inflated play pools, sport-utility vehicles with pleasure boats in tow, and all.

"Growing up here was just like small-town U.S.A.," Robert said, as we sat in their living room surrounded by packing cases. "The only difference was, I'd come home from school and wham! right out into the jungle: building forts, catching butterflies, fishing for tarpon, hitting the beaches. We played basketball, baseball, and football, just like in the States." Denise remembered being surprised when she first noticed that people didn't lock their cars or their houses. "Of course, that's changing now that we don't have our Canal Zone police anymore."

The Wills have decided to move to Daytona Beach, a popular retreat for Americans leaving Panama, where the climate and pace of life are familiar. Robert said he could keep his job under the Panamanians, but it would mean losing their 15 percent "tropical differential" and their annual five weeks of paid home leave. "You could say we were coddled, I suppose, but that's always been the system," he explained. Denise looked up and smiled. "It was a great ride while it lasted," she said. □

With the new millennium, Panama will control the Canal Zone. Was the U.S. presence a boon or a bane? Comment online at *www.nationalgeographic.com/ngm/9911.*

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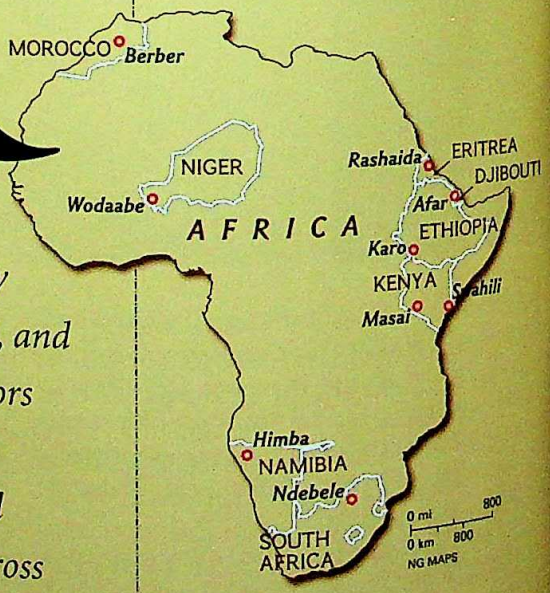
African Marriage Rituals

ARTICLE AND PHOTOGRAPHS
BY Carol Beckwith
AND Angela Fisher



IT TOOK TEN YEARS *of crisscrossing Africa by four-wheel drive, camel, and mule train for the authors to chronicle the rituals shown here. Traditional weddings are fading across the continent in the wake of modern culture, yet those remaining constitute some of the finest examples of these age-old ceremonies.*

A veil of gold cannot hide the beauty of an Afar sultan's daughter in Djibouti. Even among families of modest means, traditional African marriages can be elaborate celebrations that last for days.

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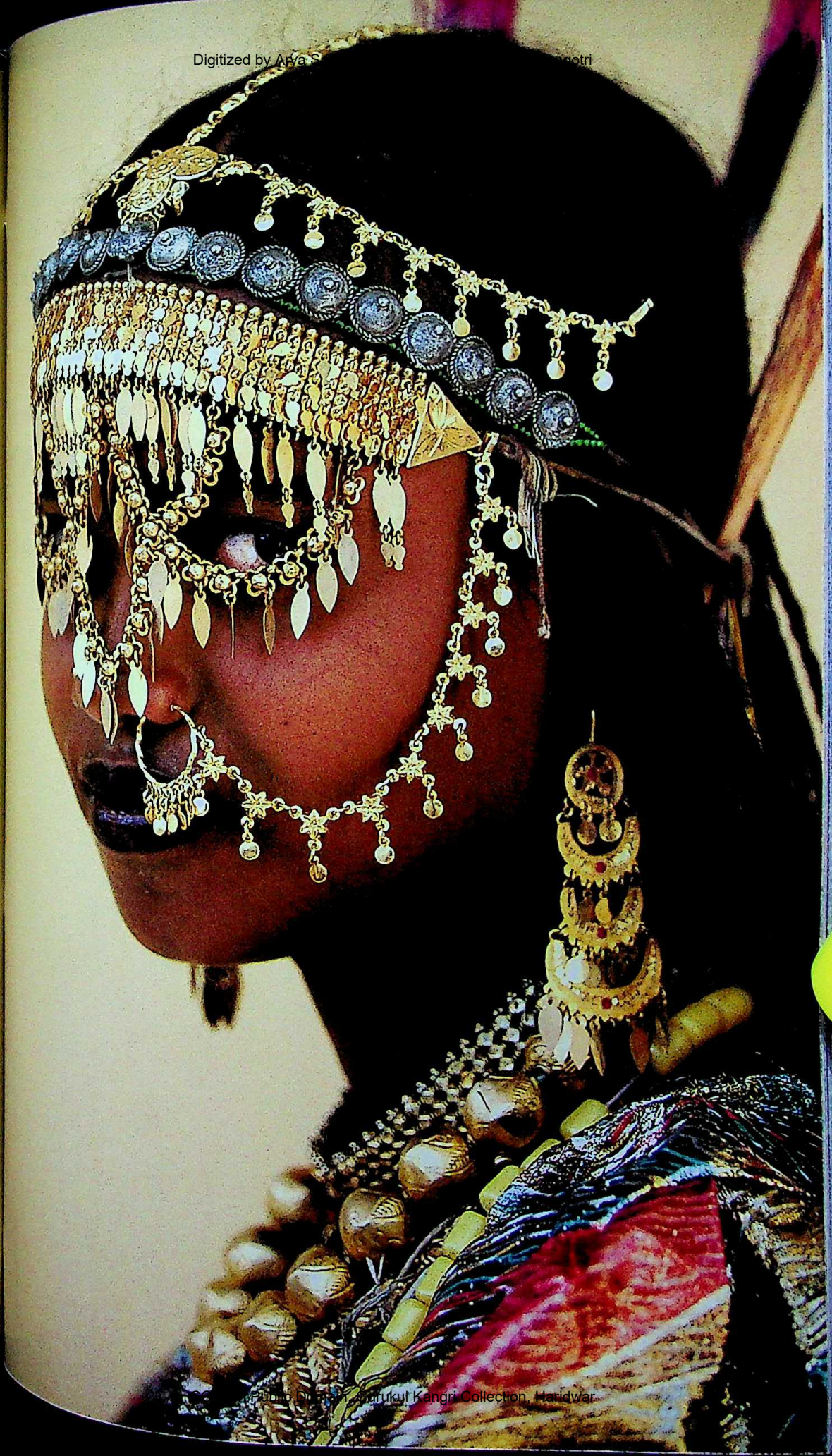

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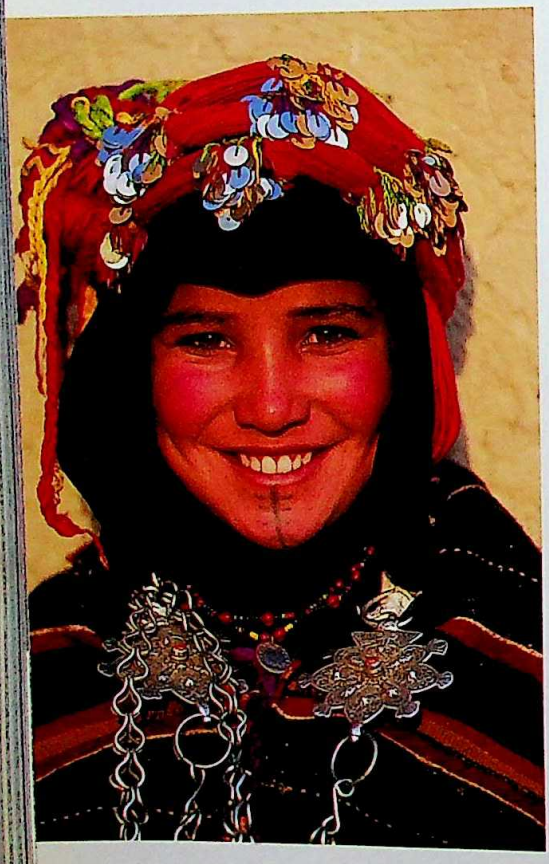
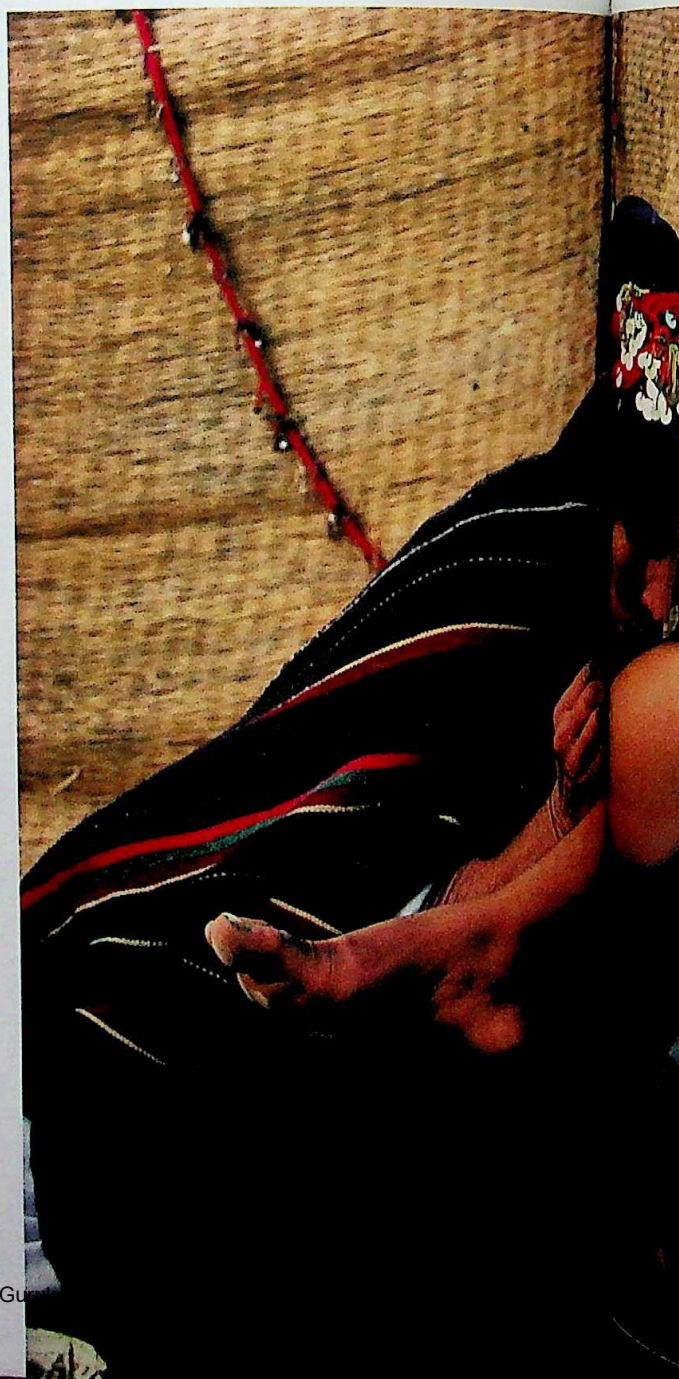
Berber

In Morocco's High Atlas mountains virgins like 12-year-old H'dda (below left) may catch the eye of a suitor at the annual brides' fair in the village of Imilchil. If her parents approve, a prolonged courtship begins. Under Moroccan law girls cannot marry until 16, but many Berbers keep their own counsel. For widows and divorced women the Imilchil fair is an open market, with marriages sealed on the spot. Before a young bride's wedding her mother rubs her legs with henna, a ritual that her people,





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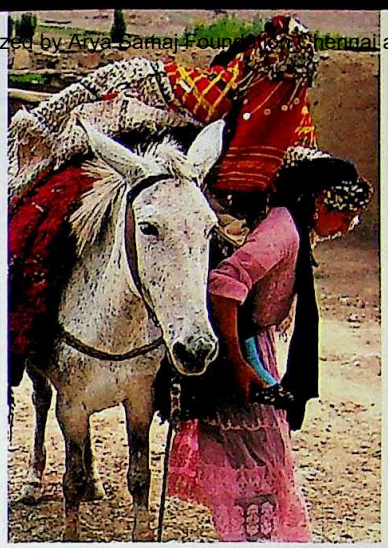
the Ait Hadiddou, believe repels jinn, or evil spirits.

Conveying blessings and bittersweet good-byes, a mother plants a kiss on her daughter's knee (below) as she gives her in marriage to a man more than twice her age. After a time of seclusion following the ceremony, the girl will travel by mule to her



husband's home. Once there, one of his female relatives lifts her off (left) so her feet don't touch the ground and risk evil spirits entering her body.

Days of feasting weave into nights of singing and dancing for the bride, who has captured the liver—the Berber embodiment of love—of the man sworn to protect her.

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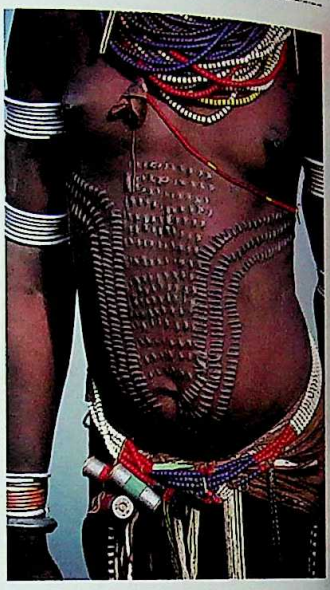
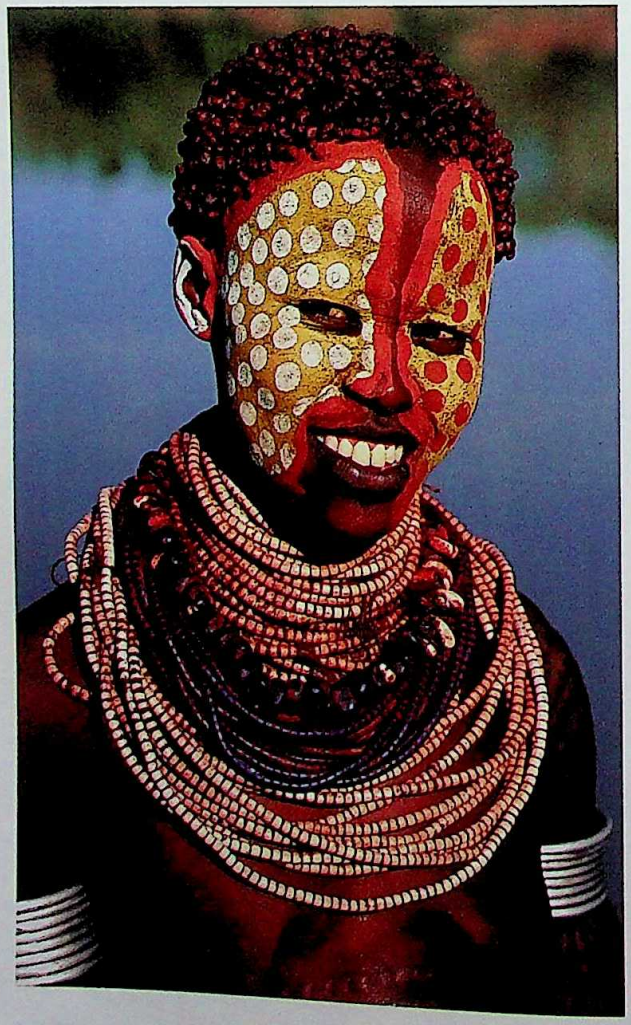
Karo

The beauty of Ethiopia's Omo River Valley is matched by its people, who decorate their bodies to enhance their looks and attract the opposite sex. The 500 or so Karo have little material wealth, so they rely on nature and trade for what they need to adorn themselves. When a Karo girl reaches puberty, she endures the pain of scarification as razorlike cuts are incised into the skin of her abdomen. Ashes rubbed into the wounds make them heal in an elaborate raised pattern (right). This, Karo men told us, increases her desirability.





Other cosmetic enticements glow from the face paint that a woman named Kawo has applied to herself (left). Imitating a guinea fowl's spotted plumage, her striking palette is made from pulverized iron ore, yellow rock, and white chalk. A string of black wild banana seeds sits atop lengths of Czech glass beads traded at a small market more than three days' walk away.

When the summer has passed and the harvest of beans, corn, and sorghum is complete, courtship season begins. The eligible Karo, turned out in all their splendor of paint, beadwork, and aluminum bracelets, join in exuberant dances (right). A man signals a partner by thrusting his hips her way. So begins an evening of rhythmic dancing and singing. For many the excitement will lead to betrothal, marriage, and a lifetime together.

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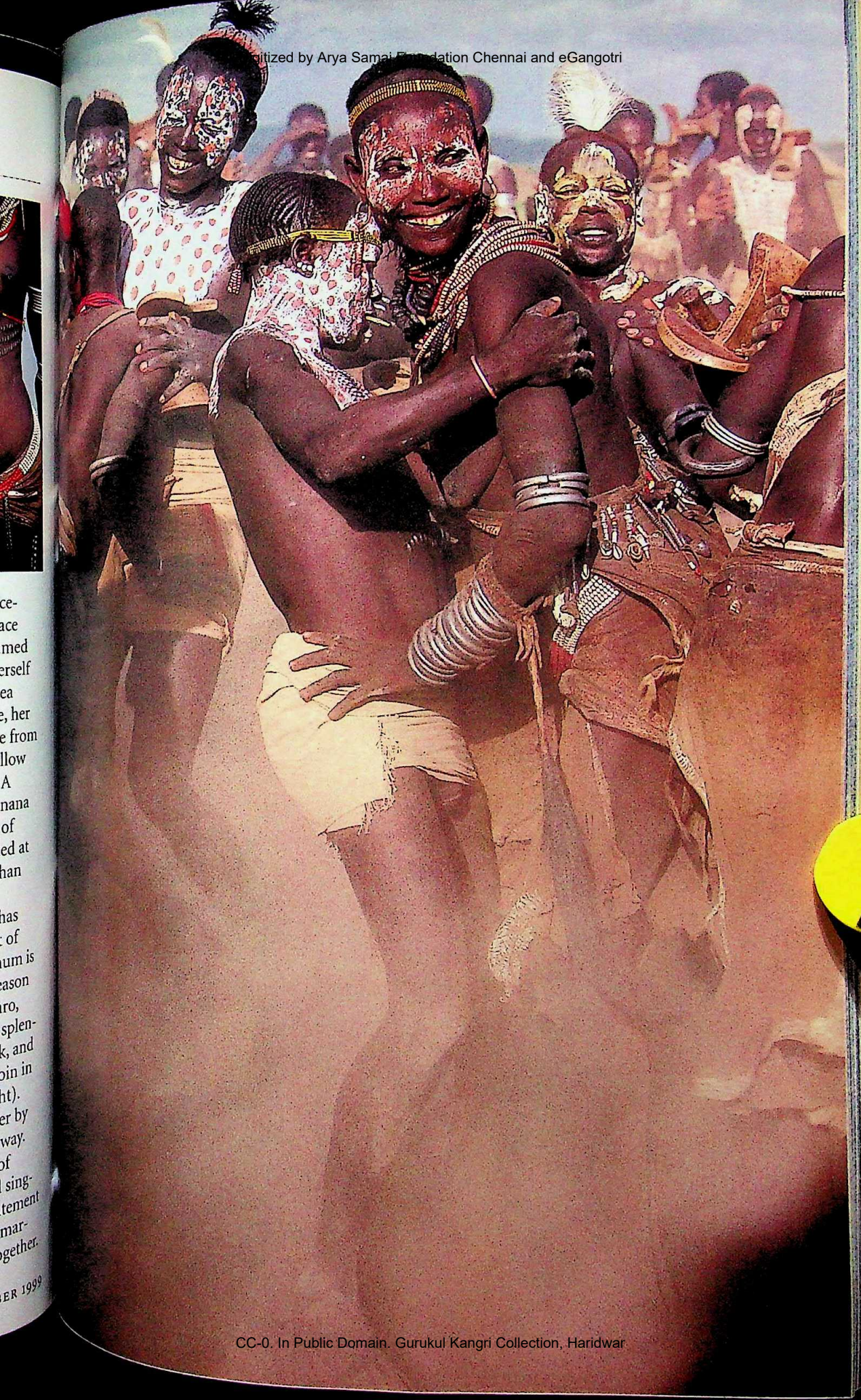

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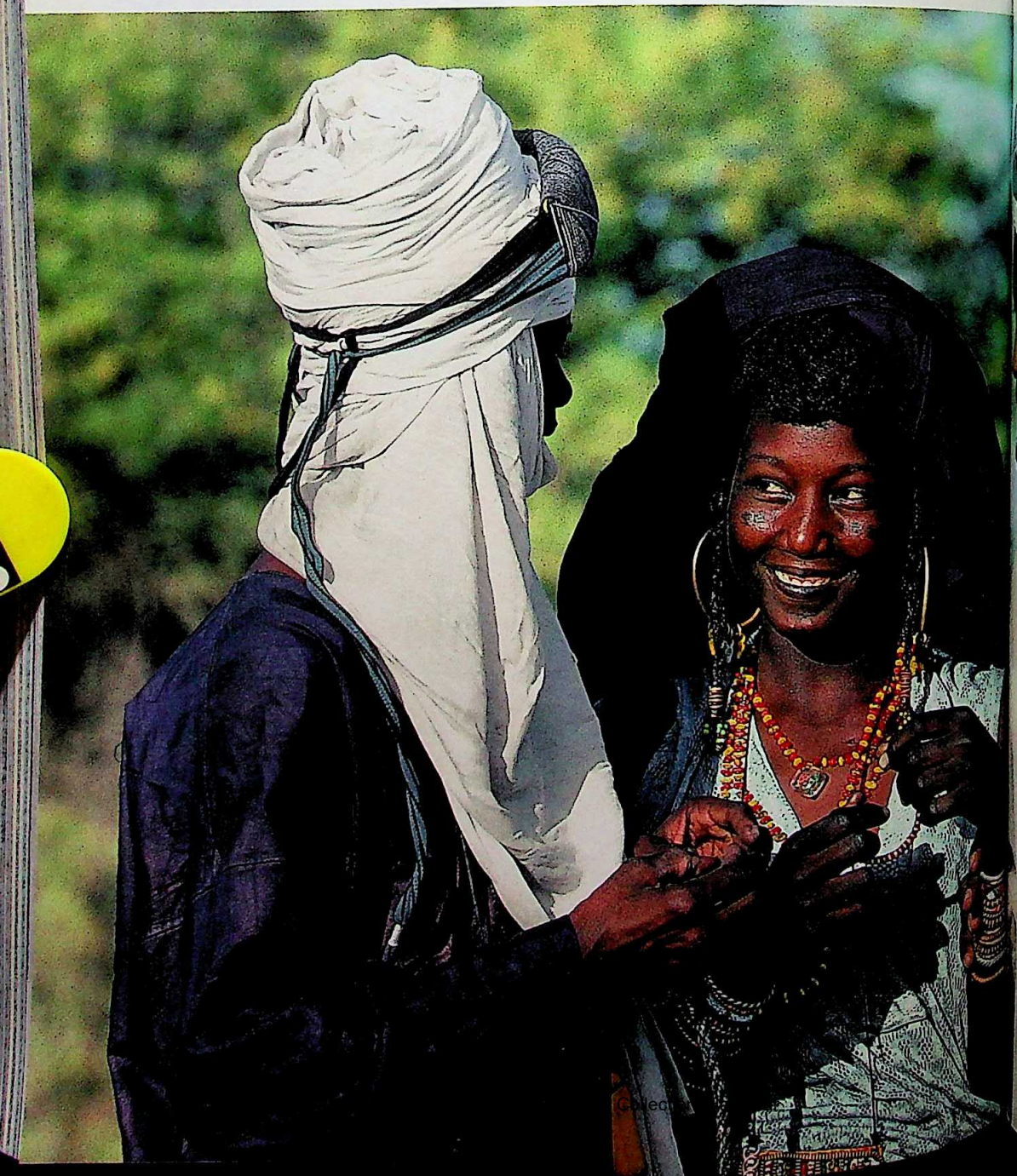
Wodaabe

All eyes are on smiling Mobobo (below), who holds the hearts of her two suitors, who are cousins. Wearing their most potent talismans to enhance their charm, they vie for her attention. Only among the Wodaabe, nomadic pastoralists in the Sahel of Niger, have we seen such a custom: Male cousins about the same age, called *wal-deebe,* who share a special bond, sometimes also share affection for the same girl. If she marries one, the other is welcome in their home and, with her consent, in her bed.



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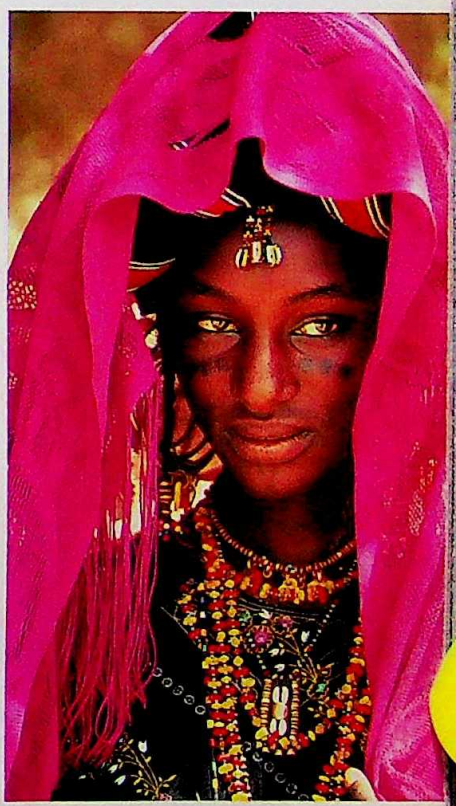
Rules of social conduct are paramount to the Wodaabe, "people of the taboo." Their code of behavior emphasizes reserve and modesty—*semteende*—perfectly expressed in the demeanor of Mojendeybu (below) as she prepares to marry. In customary Wodaabe form, she averts her glance beneath a fringed veil.



Grand displays are in order during an annual festival called Worso, which celebrates the year's births. Women decorate beds given to them by their husbands after the birth of their first child. One woman (top) framed hers in plastic bits and streamers, silver thumbtacks, and beach balls. The women whose beds are judged best are honored with songs that enter Wodaabe oral history.

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Swahili

Elevating a glance to an art form, Khadijah (below left) says with her eyes what Swahili women in Lamu, Kenya, are forbidden to say in words. Socially segregated by strict Islamic law, a woman shrouded in a black *bui-bui* may attract a man's attention when she appears in public with friends, but most marriages are arranged.

A Swahili wedding is filled with rituals designed to beautify the bride and heighten the senses. Several days before her marriage Fatima undergoes a series of treatments. All her body hair below the neck is removed. She is then massaged with coconut oil and perfumed with sandalwood. With twigs dipped in henna, women draw designs on her limbs (opposite). An older woman, called a *somo,* teaches Fatima how to please her husband, even, perhaps, waiting under their bed to assist in case the couple have difficulty consummating the marriage.

On the wedding day (below), the groom lifts the veil of his bride—whose face he may be seeing for the first time—and gives her a necklace of gold or coral. The partner whose hand ends up on top in the playful exchange is believed to have the upper hand in the marriage. The wedding is sealed in an all-male ceremony in a mosque.

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Ndebele

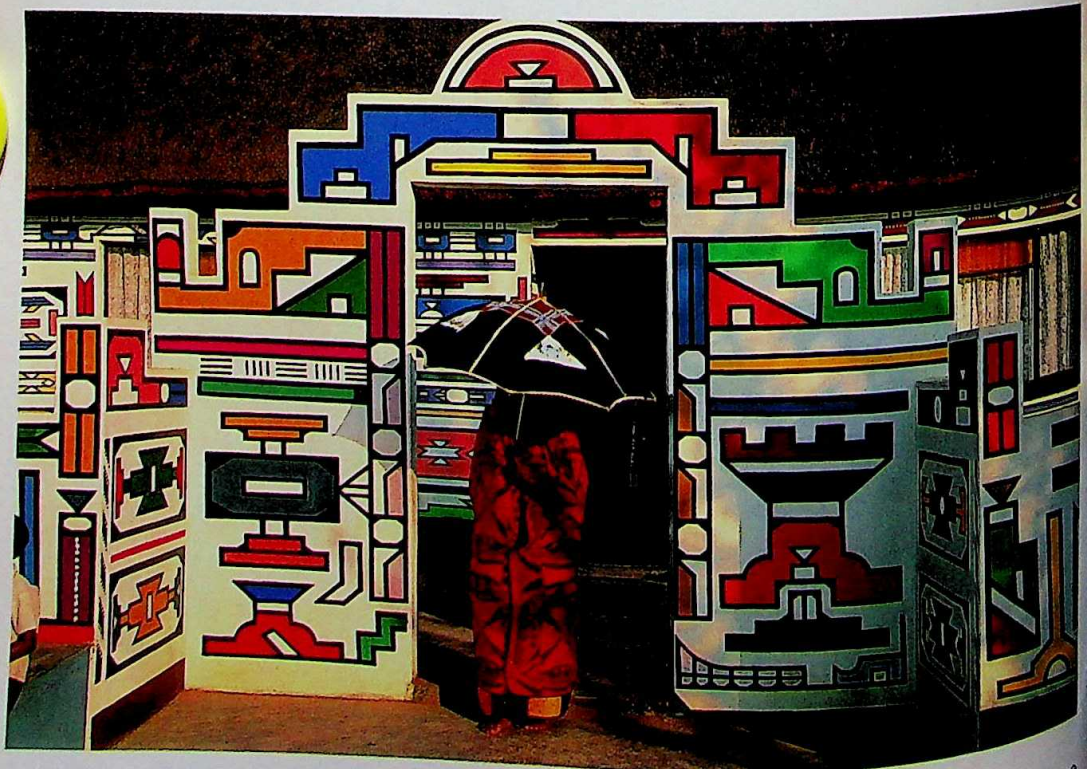
While documenting the art of Ndebele housepainting, we learned of a wedding to take place in a family homestead north of Pretoria, South Africa, where the Ndzundza Ndebele raise cattle and grow corn and millet. Ndebele weddings are celebrated in three stages, which can take years to conclude. They begin with the negotiation of *lobola,* or bride price, paid in installments of money and livestock.

A two-week seclusion of the bride-to-be marks the second stage, when other women teach her how to be a good Ndebele wife.

Coming out of seclusion, Zanelle shows off the heavily beaded attire she wore for her initiation into womanhood a year or so before (opposite). Colorful beaded hoops called *golwani* encircle her waist and legs, imitating the voluptuous female form so admired by the Ndebele.

Later, in a show of shyness expected of Ndebele women, she stands with downcast eyes, wrapped in her marriage blanket (left), which she will wear at special events for the rest of her life. At the threshold of the freshly painted gateway of a relative's courtyard (below), Zanelle shields herself with an umbrella, a Western accessory adopted by Ndebele women for modesty.

Zanelle is truly married only when she completes the third stage: giving birth to her first child.



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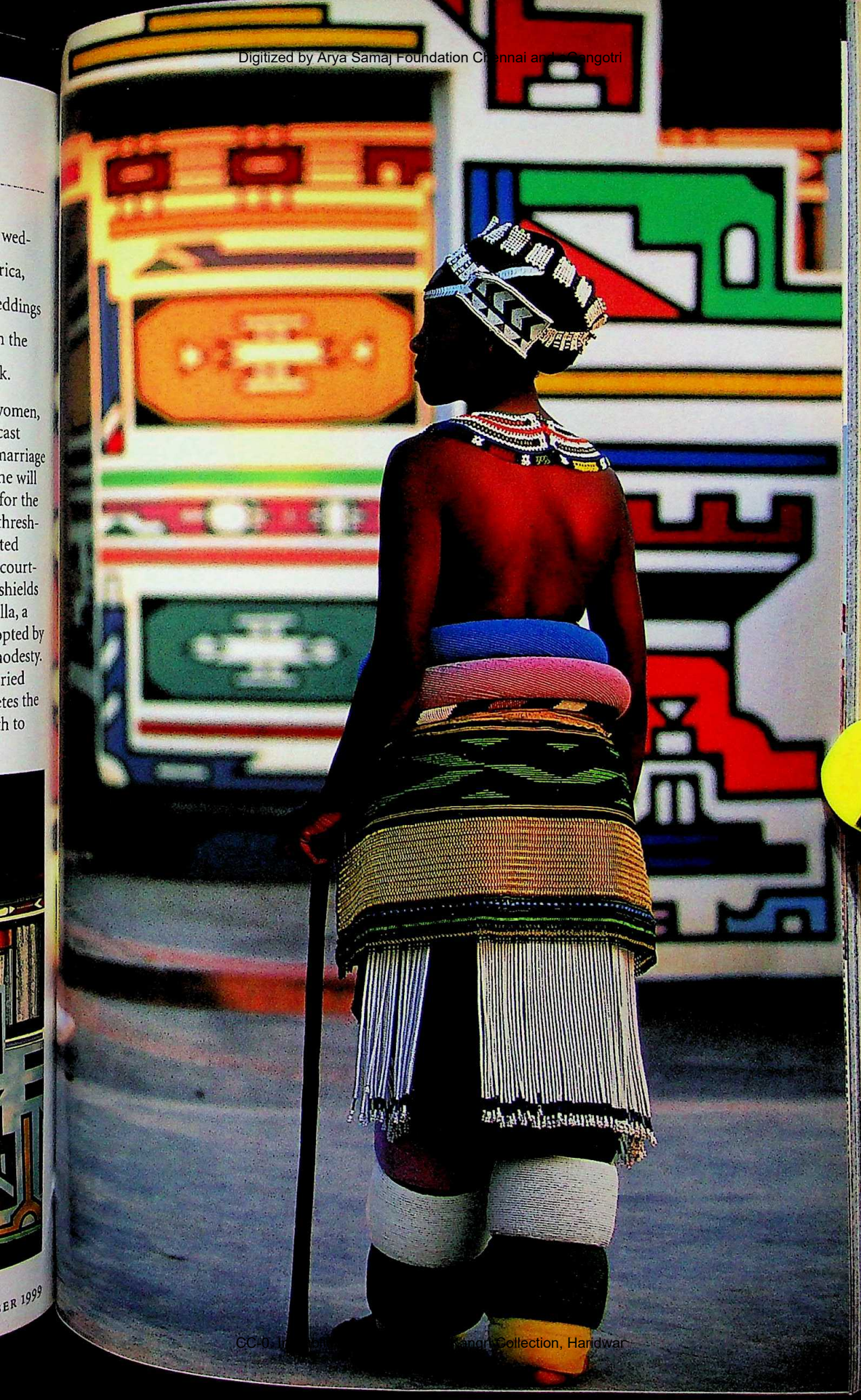

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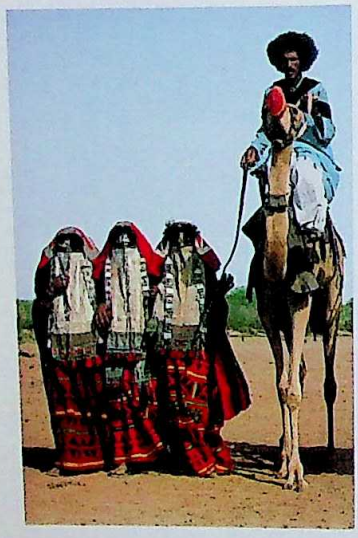
Rashaida

Reaching the Rashaida wedding wasn't easy. Besides the threat from land mines left from the Eritrean war with Ethiopia, our Land Rover's wheels repeatedly sank in the desert sand. All told, we stalled seven times, once for nearly seven hours, digging out with only a frying pan, three pots, and our bare hands. So it was a relief to reach the nomadic Rashaida and be greeted by women bearing gifts of silver rings.



The Muslim Rashaida are Bedouin merchants and renowned camel breeders, originally from Saudi Arabia. Except for trading, they keep to themselves, and they marry only their own.

Guests begin to arrive as we settle in. One man, perched high on a camel (left), escorts his three veiled wives to a wedding week of camel racing, dancing, and feasting on goat meat, wheat porridge, and sweet tea.

Bekiita, the bride, stays in seclusion, veiled behind an elaborate mask called a *burga* (right), which she has painstakingly decorated with silver thread and pendants given to her by the groom.

When the day cools at sunset, a woman breaks into a dance (below). Clapping out the rhythm, the men sing: "The sun is setting, so we sing before the dark!" As she swirls in perfumed skirts, they punctuate their song with shouts of tribal pride: "Rashaida! Rashaida!"

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Himba

In the silent darkness of her hut, Ngororo places an *ekori,* a leather marriage headdress passed from mother to daughter, on 15-year-old Kavekaha (below). When the bride is ritually kidnapped by her new husband and his family, the ekori—its back shaped like the ears and horns of a cow—is rolled down to cover her face.

Symbolism surrounds the Himba, who herd cattle in Kaokoveld in northwestern Namibia. The women slather themselves with red ocher and butterfat mixed with

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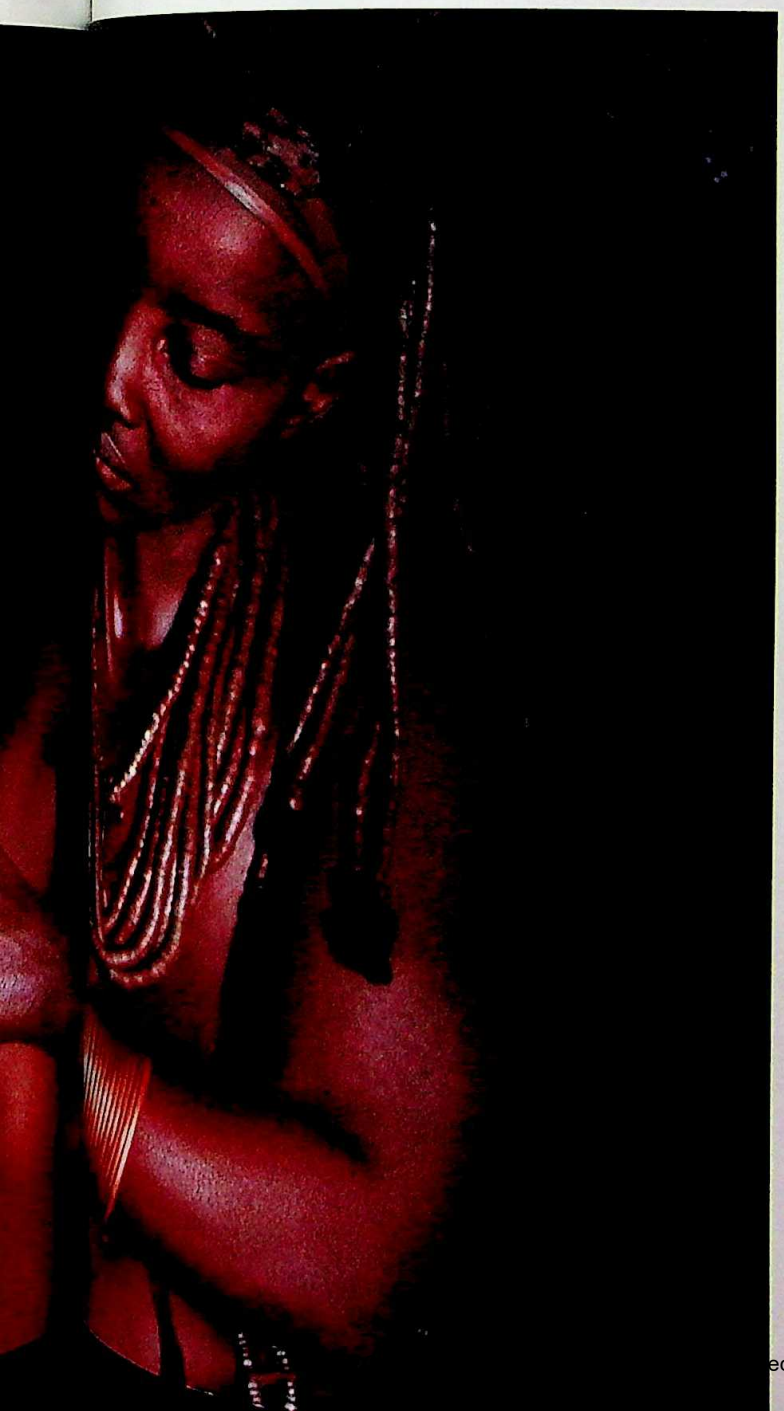
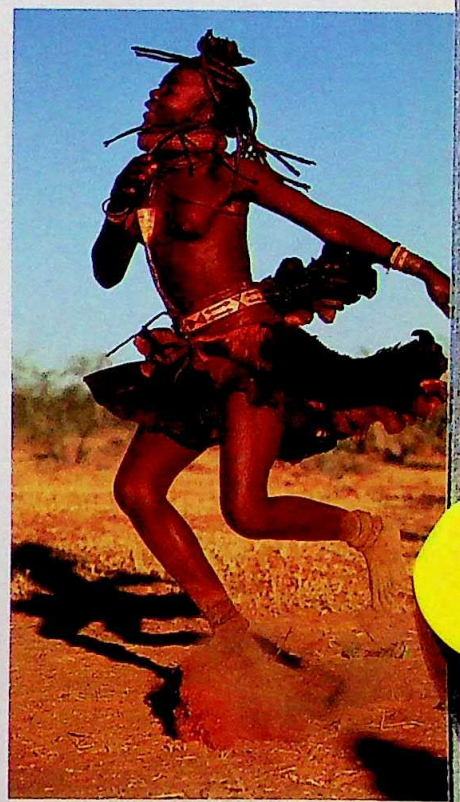
herbs and resin, displaying the rich red color of earth and blood that symbolizes life. For the wedding itself, Kavekaha wore a fresh covering scented with the ground rinds from oranges we presented her.

The day before, a lively celebration honored the couple. To the beat of singing and clapping, Verigera led the





ondjongo dance, spreading her arms to imitate the horns of a cow (top). Kavekaha's best friend kicked up a little dust with her own energetic dancing (above).

Arriving at her husband's home, the bride is instructed on the duties expected by her new family, who show their acceptance by anointing her arms, breasts, and belly with butterfat from the cows of the groom or his father.

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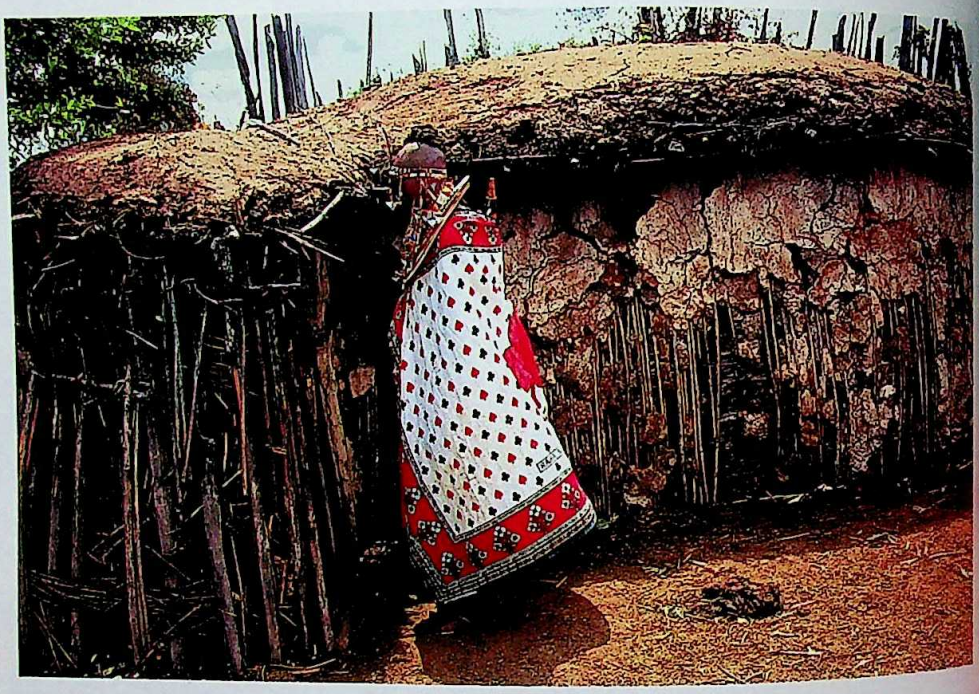
Masai

A single tear marks the moment of farewell for lavishly beaded Nosianai (right) as she leaves her family home in the Loita Hills of southern Kenya. Wedding-day tears may express true sadness among Masai girls, who submit to arranged marriages with much older men whom they barely know. Before she departs, Nosianai's



father spits a blessing of milk on her head and breasts (left), saying, "*Mekinchoo enkai enkerra kumok*—May God give you many children." As she leaves, family and friends warn her not to look back, voicing the superstition that she will turn to stone. The groom's attendant makes certain that nothing obscures the bride's path to her new husband's home, removing branches and leaves and even carrying her across streams.

As the bridal party nears, they are met by the groom's female relatives, who hurl insults at Nosianai to ward off bad luck. "You are as short and bowlegged as a Pygmy!" they shout, the ultimate slur to typically tall Masai. Then they slap handfuls of cow dung on top of her head. How she handles the abuse is believed to determine how she will face the challenges of marriage.

At her mother-in-law's hut (above), Nosianai follows Masai tradition by formally refusing to enter until she is satisfied with the gifts her new family offers.

CAROL BECKWITH and ANGELA FISHER describe these marriage practices and other rituals in *African Ceremonies*, published this fall by Harry N. Abrams, Inc.

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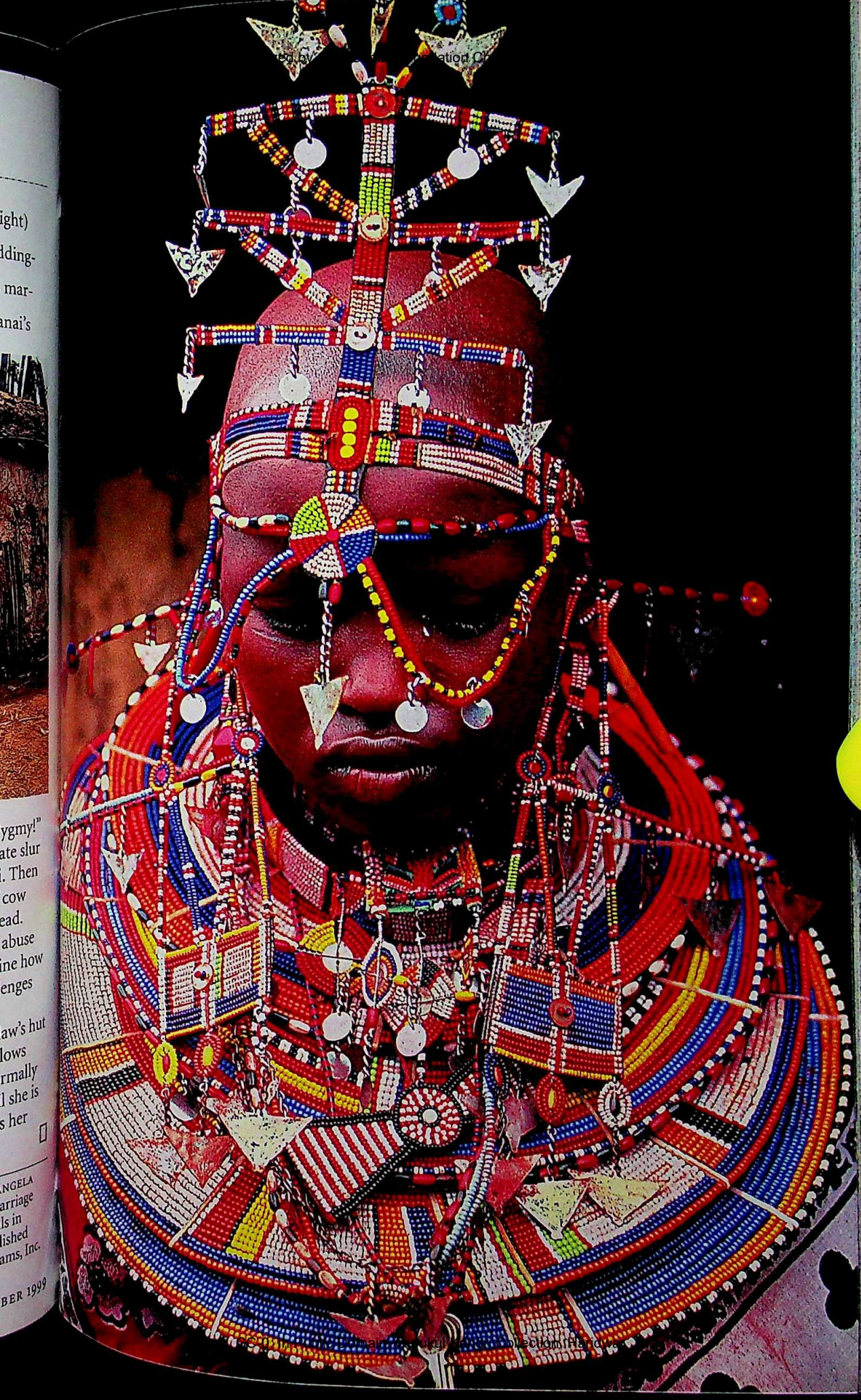

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New fossil discoveries show that feathers were more widespread in dinosaurs than previously thought. Because so many of its relatives had feathers, scientists now think *Tyrannosaurus rex* may have had them too at an early stage. Hatchlings would have shed their downy feathers as they grew.

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FEATHERS FOR T. REX?

NEW BIRDLIKE FOSSILS ARE MISSING LINKS IN DINOSAUR EVOLUTION

BY CHRISTOPHER P. SLOAN
SENIOR ASSISTANT EDITOR

PHOTOGRAPHS BY
O. LOUIS MAZZATENTA

DINOSAURS will never look the same. The reason: four new dinosaur fossils with stunningly birdlike bones and indications of feathers. Not enough to prove that these dinosaurs ever flew but strong evidence that feathers were widespread among meat-eating dinosaurs—the group that includes *Tyrannosaurus rex*.

Three of the fossils were found recently in Liaoning Province, China, the area that produced fossils of flightless feathered dinosaurs in 1996-97. All four are theropods, or meat-eaters: a dromaeosaur, one of a family of small- to medium-size predators that includes *Jurassic Park*'s "raptors"; an oviraptorosaur from Mongolia with a birdlike tail; a seven-foot-long therizinosaur; and a creature that has the arms of a bird and the tail of a dinosaur.

Twenty years ago when John Ostrom, a

ART BY MICHAEL SKREPNICK

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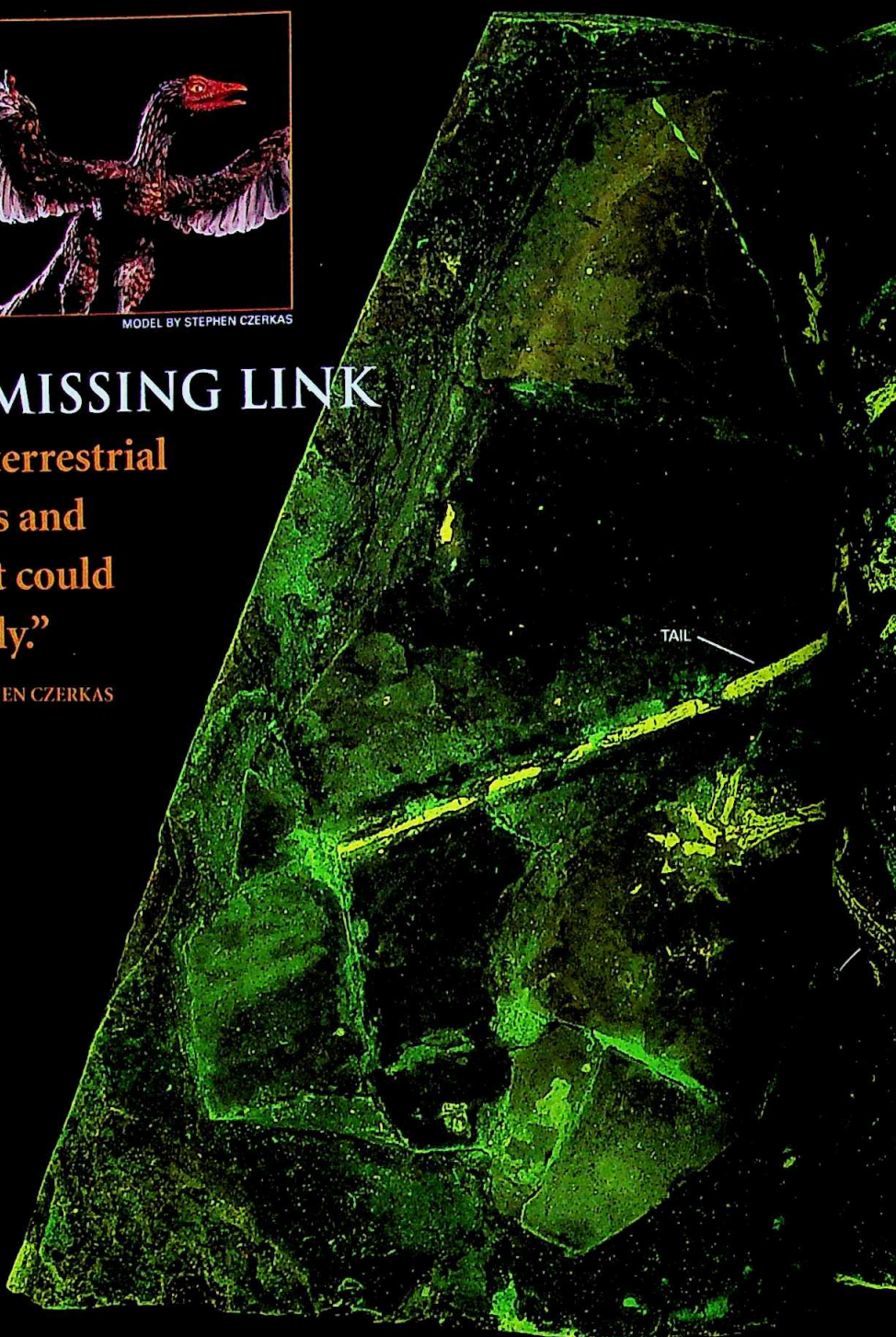
A FLYING DINOSAUR?

MODEL BY STEPHEN CZERKAS

"IT'S A MISSING LINK

between terrestrial dinosaurs and birds that could actually fly."

—STEPHEN CZERKAS



With arms of a primitive bird and the tail of a dinosaur, this creature found in Liaoning Province, China, is a true missing link in the complex chain that connects dinosaurs to birds. Scientists funded by National Geographic studied the animal, named *Archaeoraptor liaoningensis*, under ultraviolet light (above) and used CT scans to view parts of the animal obscured by rock. Preliminary study of the arms suggests that it was a better flier than *Archaeopteryx*, the earliest known bird. Its tail, however, is

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trikingly similar to the stiff tails of a family of predatory dinosaurs called dromaeosaurs. This mix of advanced and primitive features is exactly what scientists would expect to find in dinosaurs experimenting with flight. Stephen Czerkas, who led the study of the specimen, reconstructed the new animal (inset), which resembles *Archaeopteryx*. "This fossil is perhaps the best evidence since *Archaeopteryx* that birds did, in fact, evolve from certain types of carnivorous dinosaurs," says Czerkas.

Digitized by Arya Samaj Foundation Chennai and eGangotri

respected paleontologist at Yale University's Peabody Museum of Natural History, proposed that birds descended from theropods, many scientists viewed him as a radical. But the clear impressions of feathers on the Liaoning fossils lengthen the list of feathered theropods, and we can now say that birds are theropods just as confidently as we say that humans are mammals. Everything from lunch boxes to museum exhibits will change to reflect this revelation.

A simple paper sign with "Chris" scribbled on it, tacked to a weathered post, is my signal to turn into the Czerkas ranch in southeastern Utah. It's May 1999, and I'm about to meet up with one of the Chinese specimens that, right now, only a few people know about. Stephen and Sylvia Czerkas, directors of the Dinosaur Museum in Blanding, found it early this year at a gem and mineral show. Immediately recognizing its scientific value, they found benefactors and purchased it quietly, planning to give it a home in the museum. "We wanted to make sure it didn't end up on a mantel in someone's private collection," says Sylvia.

RESEARCH PROJECT

Supported in part by your Society

According to Chinese officials any fossils leaving China—including countless bird specimens and dinosaur eggs that have appeared on the international market—are illegal exports. So, after completing their study of the fossil, the Czerkases now plan to return it to China.

Stephen draws me into a back room to view the animal he will later name *Archaeoraptor liaoningensis.* I've seen feathered dinosaur specimens, but what Stephen shows me takes my breath away. Its long arms and small body scream "Bird!" Its long, stiff tail—which under magnification erupts into a series of tiny support rods paralleling the vertebrae—screams "Dinosaur!"

Surrounding the bones, which suggest that the animal is a dromaeosaur-like primitive bird, are the remains of feathers. Some are similar to the hairlike protofeathers of the flightless *Sinosauropteryx* found in 1996.* But others look long and broad, seductively suggesting flight feathers. "It's a missing link," Stephen says. "We can't prove that it flew, but the feathers, its anatomy—long arms, birdlike shoulders, hands, and wrists—doesn't make sense unless it did."

Three weeks earlier I had viewed the other two Liaoning fossils at the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing. The first, a dromaeosaur, was an eagle-size creature named *Sinornithosaurus millenii,* "Chinese bird-reptile of the millennium." It was exquisitely fierce looking, with barracuda-like teeth and long curved claws. It reminded me of John Ostrom's description of dromaeosaurs: "bizarre killing machines."

Paleontologist Xu Xing showed how the bones of *Sinornithosaurus millenii*'s shoulder girdle—the scapula, coracoid, and furcula—are more like those of a bird than those of a dinosaur. Critical for flight, these bones join at the glenoid fossa, a cup-shaped area that determines the degree to which a bird can raise its wings above its shoulder to flap. "If you saw just this shoulder girdle, you would think it was *Archaeopteryx,* the earliest bird," he said.

In a room across a dimly lit hall Xu

*See "Dinosaurs Take Wing," by Jennifer Ackerman, in the July 1998 NATIONAL GEOGRAPHIC.

FROM GROUND TO AIR

Fast, bipedal meat-eaters called theropods have four new species: *Sinornithosaurus millenii, Beipiaosaurus inexpectus, Archaeoraptor liaoningensis,* and an unnamed oviraptorosaur. Beginning with the primitive *Sinosauropteryx,* all theropods, including *T. rex,* may have had feathers, one of the adaptations that led to flight in *Archaeopteryx* and perhaps *Archaeoraptor.*

Former Senior Assistant Editor LOU MAZZATENTA photographed evidence of the earliest life on Earth for the magazine's March and April 1998 issues.

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showed me the other feathered dinosaur, *Beipiaosaurus inexpectus*, one of only a few therizinosaur specimens known. Farmers discovered the gray bones near the town of Beipiao and discarded them, believing they had no commercial value. Xu and his colleagues chanced upon scraps of the fossil and salvaged the remaining pieces from the site.

The young scientist handed me a flat piece of rock about the size of my hand. It bore

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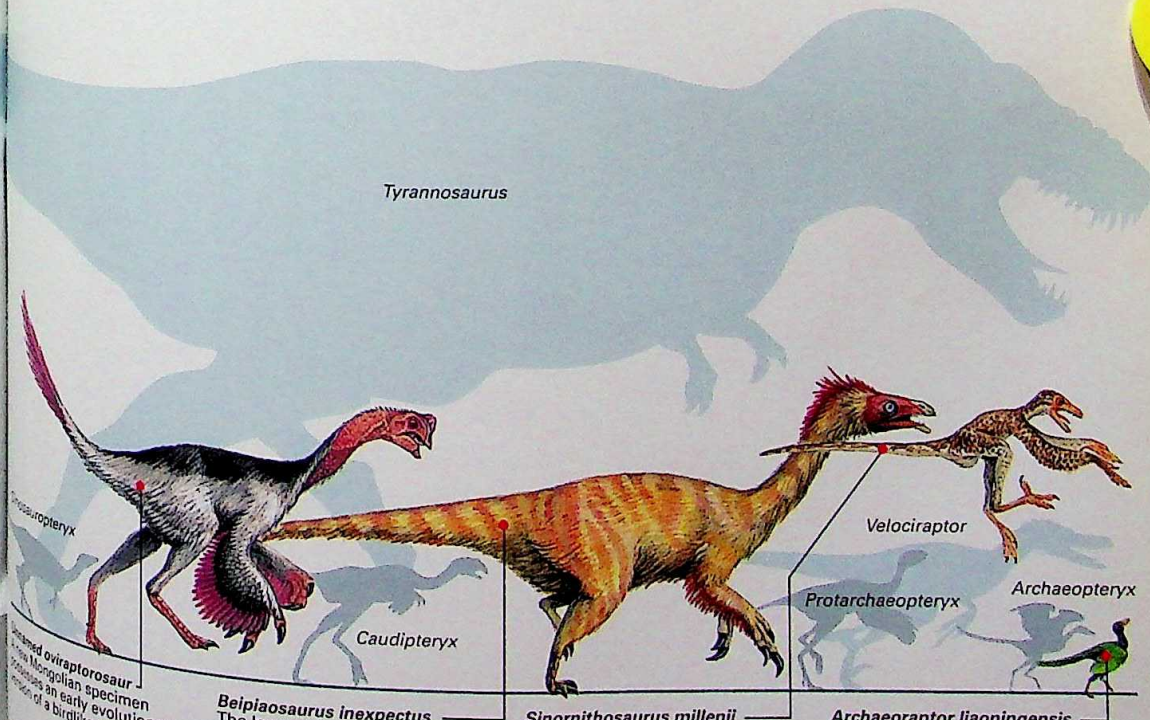
pinkish, ovoid impressions that suggested stiff, narrow feathers. "These filaments might have had hollow cores," he said. This is a key feature, since hollow, hairlike structures characterize protofeathers—evolutionary intermediates between reptilian skin and feathers.

At seven feet long, *Beipiaosaurus* is the largest dinosaur yet found with feathers. But why did it have them, since neither this therizinosaur nor its ancestors ever flew? One explanation is that their feathers did not evolve for flight but for insulation—which gives rise to another question: Were dinosaurs warm-blooded?

Biologist Mary Schweitzer of Montana State University, who has studied the small fibrous structures on a birdlike creature from Mongolia named *Shuvuuia deserti*, is helping to answer that question. Her tests show that the fibers are similar, chemically and structurally, to modern feathers. "The only animals living today with body coverings of hair or feathers

Obsolete model: Baby *T. rex* in 1997's *Lost World: Jurassic Park* probably would have feathers if the movie were made today.



FEATHERS FOR T. REX?

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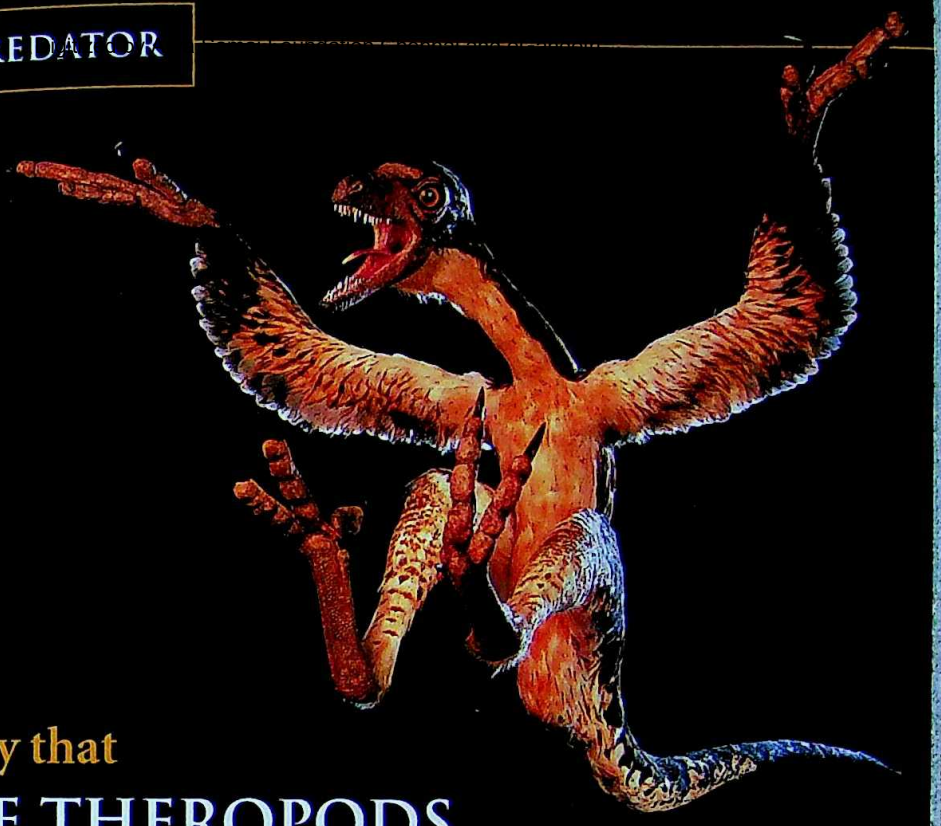
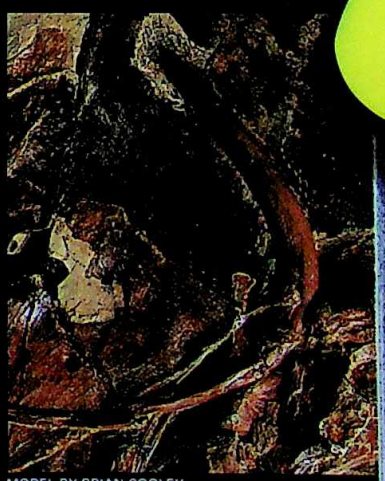


We can now say that
BIRDS ARE THEROPODS
just as confidently as we say that humans are mammals.

Halo of feathers radiates from the fossilized bones of *Sinornithosaurus millenii* (left), which lived more than 120 million years ago. A sculptor's depiction (above) shows it pursuing prey; it probably fed on lizards and small mammals. Although the creature was apparently covered with downy feathers, it could leap but not fly. However, its boomerang-shaped furcula, or wishbone (far right), resembles that of the primitive bird *Archaeopteryx*, according to paleontologist Xu Xing. Resting near two claws, the tail vertebrae anchor bundles of slim bony rods (below) that stiffened the tail to aid maneuverability. This feature identifies *Sinornithosaurus* as a dromaeosaur, one of the most effective predators of its day. The fossil also supports the concept that early feathers evolved for insulation or display rather than flight and adds new weight to the idea that these dinosaurs were warm-blooded.



MODEL BY BRIAN COOLEY

PREPARING FOR TAKEOFF

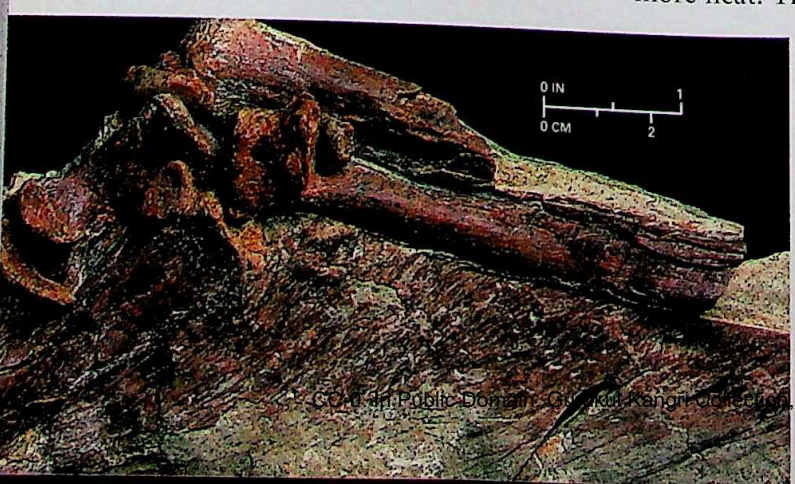
Pointed sign on the evolutionary road to avian flight, the last five vertebrae on the tail of a Mongolian oviraptorosaur are fused into a pygostyle, which in birds holds tail feathers that serve as crucial flight-control aids. In this dinosaur, however, the pygostyle may have supported feathers for sexual display.

Largest feathered dinosaur yet found, *Beipiaosaurus* was a therizinosaur, a long-necked, long-clawed theropod. Its wispy feathers, which extended two inches from the forearm (below), were used not for flight but probably for insulation. "I think therizinosaurs 'chose' a slower lifestyle, evolving from meat-eaters to plant-eaters," says Xu Xing, who is studying the fossil at China's Institute of Vertebrate Paleontology and Paleoanthropology in Beijing.

have the high metabolic rates of warm-blooded creatures," she says. "It seems reasonable to assume that this was true in the past as well. Dinosaurs that possessed body coverings were probably either warm-blooded or had metabolic rates significantly higher than those of modern cold-blooded animals."

But the larger an animal becomes, the less likely it is to need a coat of hair or feathers for insulation, since large bodies generate more heat. The last thing an adult *T. rex* in a subtropical Cretaceous world would have needed was a warm coat. "If adult *T. rex* had feathers, it was probably only for display," says Philip Currie, theropod expert and curator of dinosaurs at the Royal Tyrrell Museum in Drumheller, Alberta.

But what about *T. rex* juveniles? "Baby animals have less



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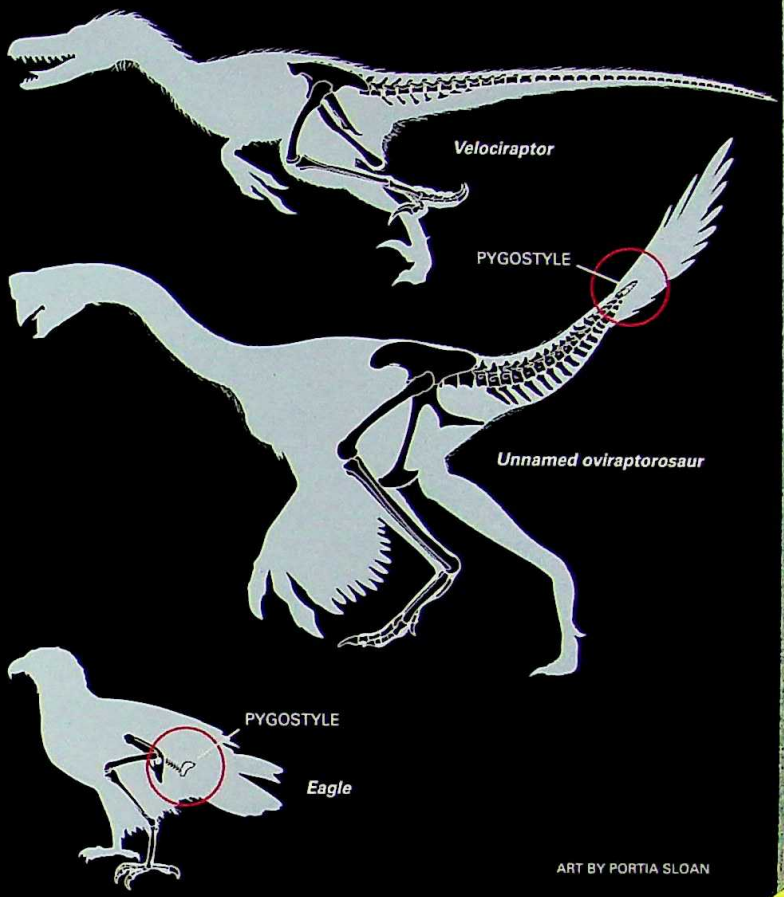
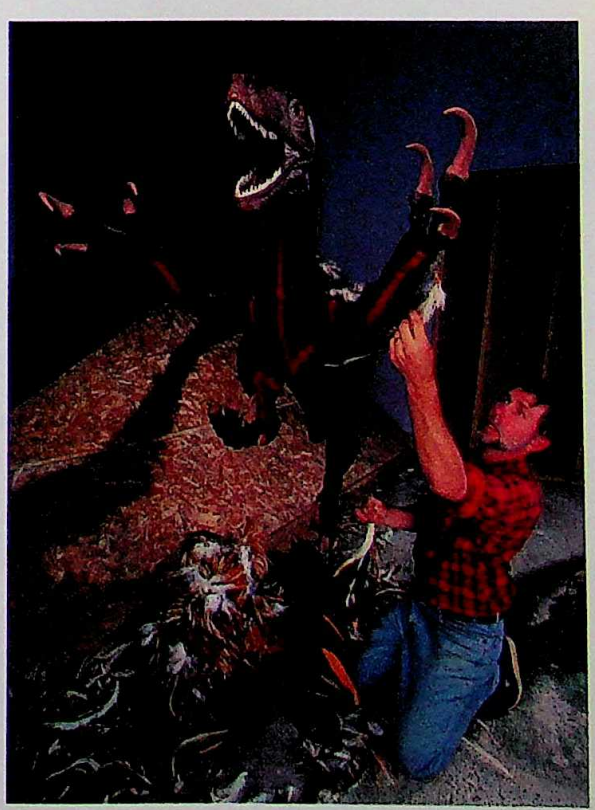
Acting as a counterbalance, the tail of *Velociraptor* (top right) is composed of many vertebrae. In an oviraptorosaur (center) the tail has fewer vertebrae and ends with an incipient version of the pygostyle. As birds evolved, the tail drastically shortened, as in an eagle (bottom). The pygostyle's tail feathers serve the bird in flight maneuvers and in displays to attract mates and intimidate rivals.



ART BY PORTIA SLOAN

Mounting fossil evidence that feathers were common among theropods led Stephen Czerkas of the Dinosaur Museum in Blanding, Utah, to add plumage to an earlier model of a dromaeosaur called *Deinonychus* (right). Depictions of many theropod species may change as museums rethink the appearance of these precursors of modern birds.



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ntrol of their body temperature than adults," ys Currie. "*T. rex* hatchlings needed a way stay warm. What would be more logical than nsulating feathers?"

A photograph of a bird in flight freezes its ings in a pose—a mere suggestion of the com- icated process of flight. In a similar way the ew Liaoning fossils create a snapshot of reptil- n skin evolving into feathers. Perhaps some- day a new discovery will capture the moment n a flying dinosaur became a bird. □

For a 3-D view of a feathered dinosaur, go to *www nationalgeographic.com/dinorama.*

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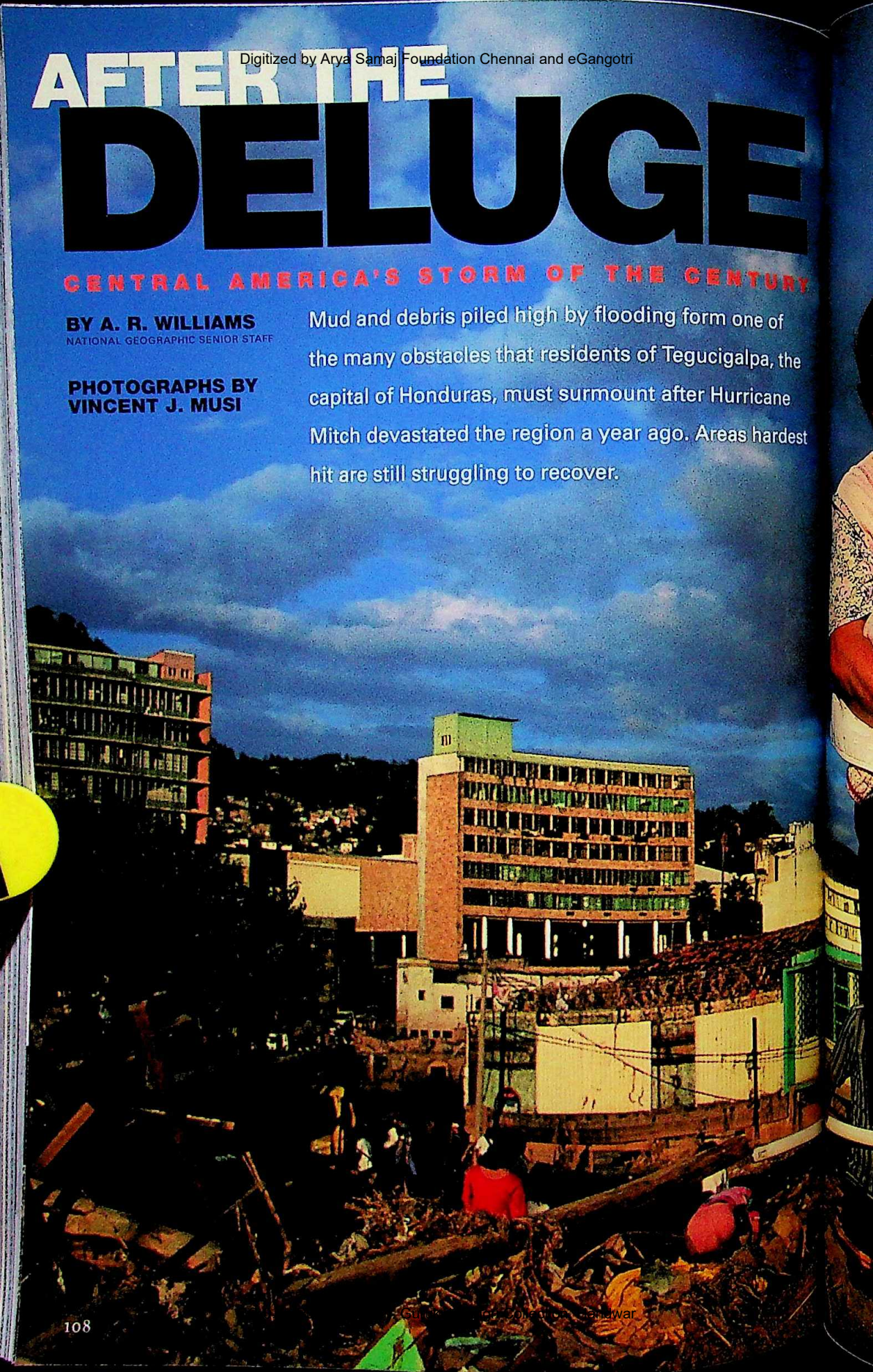
AFTER THE DELUGE

CENTRAL AMERICA'S STORM OF THE CENTURY

BY A. R. WILLIAMS
NATIONAL GEOGRAPHIC SENIOR STAFF

PHOTOGRAPHS BY VINCENT J. MUSI

Mud and debris piled high by flooding form one of the many obstacles that residents of Tegucigalpa, the capital of Honduras, must surmount after Hurricane Mitch devastated the region a year ago. Areas hardest hit are still struggling to recover.



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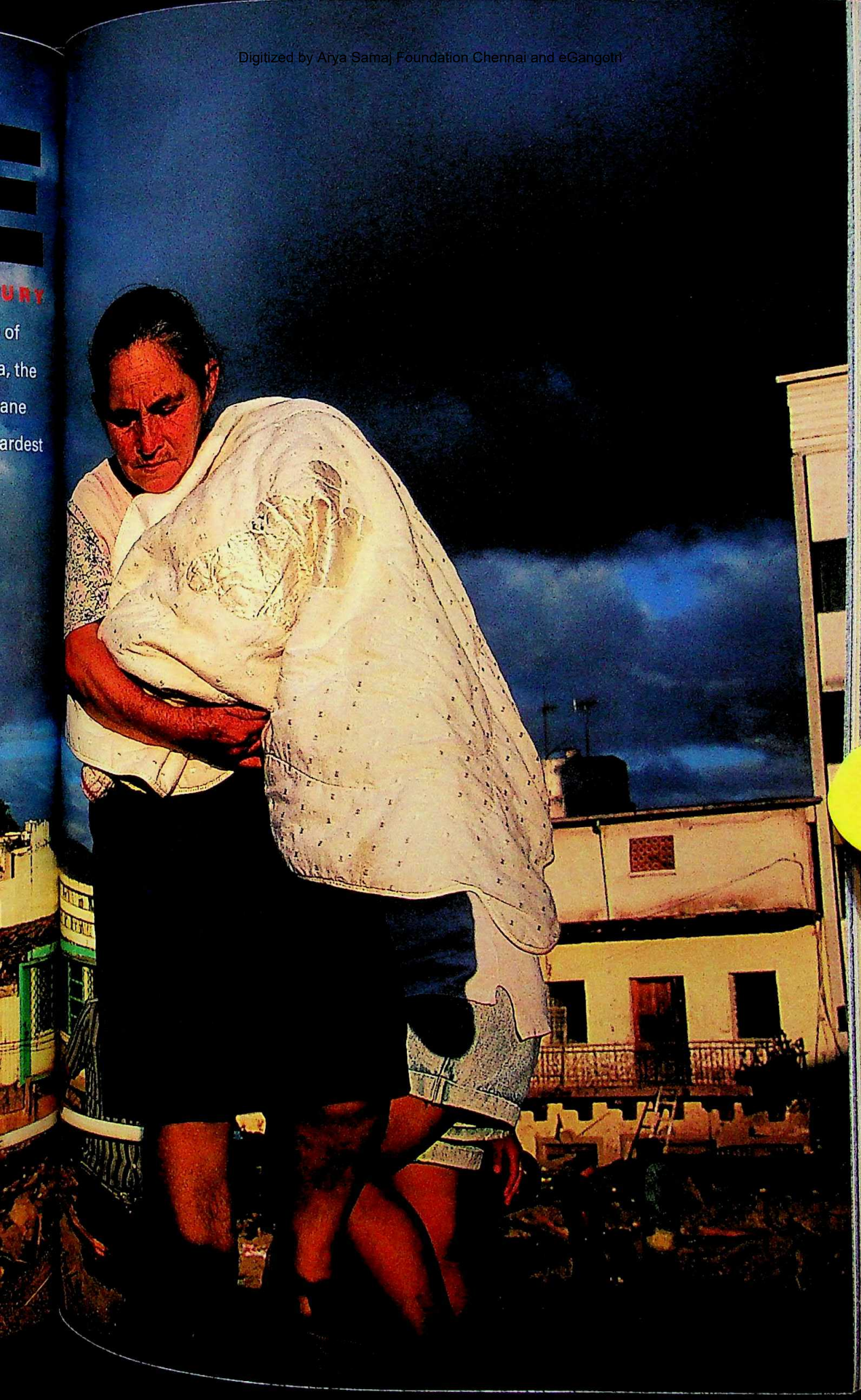

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A towering wall of mud, rocks, and uprooted trees rumbled down the south flank of Nicaragua's Casita Volcano on Friday, October 30, 1998, as men tended their fields of corn, beans, and rice and women cooked the midday meal over woodstoves in villages across the fertile green slope. It had been raining hard the whole week as Mitch—downgraded from hurricane to tropical storm—stalled. Finally the sodden earth at the top of the mountain gave way.

"We heard a sound like a plane, and we thought people had come to rescue us because our houses were filling with rain," said Vilma Urrutia Martínez, a young mother from the town of Rolando Rodríguez. "But 15 minutes later the land began to tremble, and the mud and stones were on top of us. My children and I went rolling with everything that came down, including pieces of our house."

When the mudslide ended, a deep orange gash a mile wide and ten miles long ran toward the Pacific coast. Rolando Rodríguez, with 1,600 residents and 176 houses, lost at least 455 people and virtually all its houses. El Porvenir, nearby, was also devastated, losing 79 of its 80 houses and at least 286 of its 700 inhabitants. Several other villages were sideswiped. In all some 2,000 people died.

The Casita disaster was the worst single event during a storm that killed more than 11,000, left more than two million homeless, and caused ten billion dollars in damage across the region. Nearly all of Central America was affected, from Nicaragua and Honduras through El Salvador, Guatemala, Belize, and southern Mexico. In the history of Atlantic storms only one surpasses Mitch: the Great Hurricane of 1780, which killed 22,000 people in the eastern Caribbean.

The survivors of the mudslide took refuge in schools hastily converted to shelters in towns at the base of the volcano. It was there that I visited them three weeks after the storm. When I met Vilma Urrutia, she was sitting quietly with a few relatives late one afternoon in the courtyard of an elementary school in Chinandega. At the far end two boys bounced a basketball—the only activity amid 65 stunned men, women, and children, many in bandages or casts or using crutches. "We don't know what to do," said Vilma's sister Juana. "We were left with nothing. Nothing."

Vilma had just lost two of her four children, but it wasn't until María Urrutia Ramírez, her cousin, began to speak that I began to understand everything they had been through. María, also from Rolando Rodríguez, was 38 years old and eight months pregnant. "I was stuck in mud up to my chest until they rescued me," she said. "I waited Friday, Saturday, and most of Sunday for help."

In the chaotic aftermath of the storm it had taken several days to get the word out, to round up rescuers and equipment, and to transport everyone over roads and bridges wrecked by flooding.

"I lost my daughter Ana María and her four-month-old son," María continued. "The current took them away." Two other children, Martha and Wilber, were also killed, and a 17-year-old daughter, Yasmina, who was in the hospital with a hole punched in her leg by a rock, would die a month later. Her daughters Jessica and Paula and son Yarling were bruised but all right. "My baby's due in December," she added in almost a whisper, drained by the physical and emotional shock.

Standing at María's side, 18-year-old Paula—who had lived with her husband, Ballardo Sandoval, a farmer in El Porvenir—told her story.

VINCE MUSI, a frequent contributor, first teamed up with writer A. R. Williams for our July 1997 article on the Montserrat volcano. His work has also appeared in *Life, Fortune,* and the *New York Times Magazine.*

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Days of heavy rain deluged country after country, killing thousands. In Guatemala a river rips through the town of Gualán. In Chilanguera, El Salvador, a family mourns a son who drowned. "We've seen hurricanes before," says a survivor in Honduras. "What we didn't expect was so *much* rain. There wasn't one riverbed or ravine that didn't fill with water."

ALVARO LOPEZ, *EL DIARIO DE HOY* (TOP); RAÚL MEONO, *NUESTRO DIARIO*/ASSOCIATED PRESS

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During the last days of October, late in the 1998 hurricane season, Mitch took shape off the coast of South America. Spinning northward, it became one of the strongest hurricanes ever recorded, with gusts of more than 200 miles an hour. As it slowed to a tropical storm and began to crawl across Honduras, rain replaced wind as the destructive force. Runoff eroded mountainsides and fed rivers that scoured valleys. The Choluteca River overran its banks and in its southernmost stretch dumped sand, mud, and stones on part of the city of Choluteca and nearby farms (1). Along the Nicaraguan coast runoff built a delta at the mouth of an inlet and swirled for miles into the Pacific Ocean (2).

San Pedro Sula

San Salvador

Tegucigalpa

Pacific Ocean

1 Choluteca

2

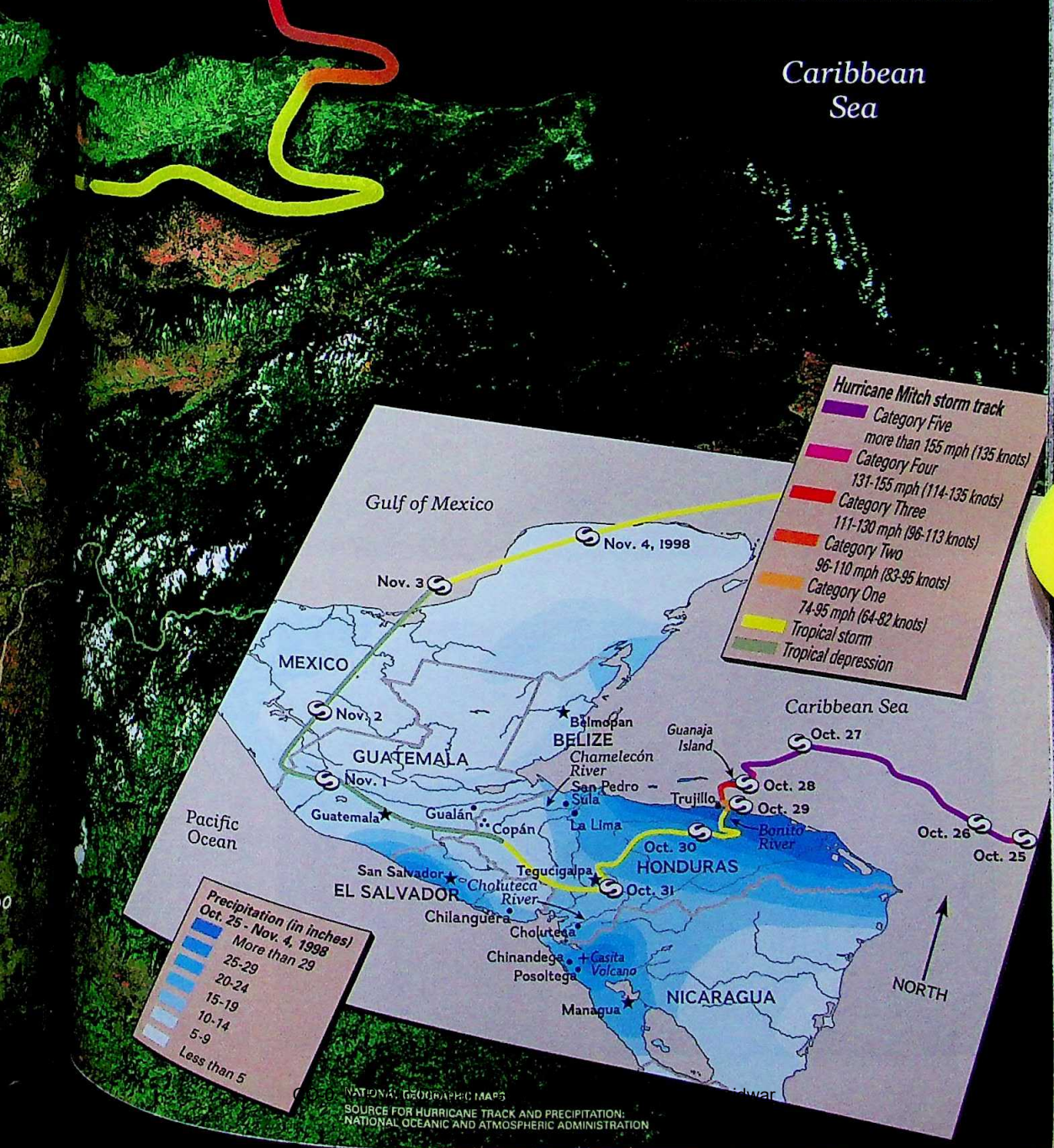
Casita Volcano

"Slow-moving tropical weather systems near the mountainous land areas of Central America and Mexico inevitably lead to huge amounts of rainfall," says meteorologist Richard J. Pasch of the National Hurricane Center in Miami, Florida. Yet even among such systems Mitch was exceptional, dumping three or more feet of rain on some places. "Nothing like this ever happened here before. Not Hurricane Fifi, not Gilbert, never," says a shop owner in Tegucigalpa, citing the big storms of 1974 and 1988. "We got a little water in the streets, but not a flood."

LANDSAT MOSAIC BY U.S. GEOLOGICAL SURVEY/EROS DATA CENTER; NOAA SATELLITE IMAGE (GLOBE AT TOP) PROCESSED BY GODDARD SPACE FLIGHT CENTER, NASA

A TRAIL OF DESTRUCTION

U.S. GEOLOGICAL SURVEY/EROS DATA CENTER (BOTH)



NATIONAL GEOGRAPHIC MAPS

SOURCE FOR HURRICANE TRACK AND PRECIPITATION: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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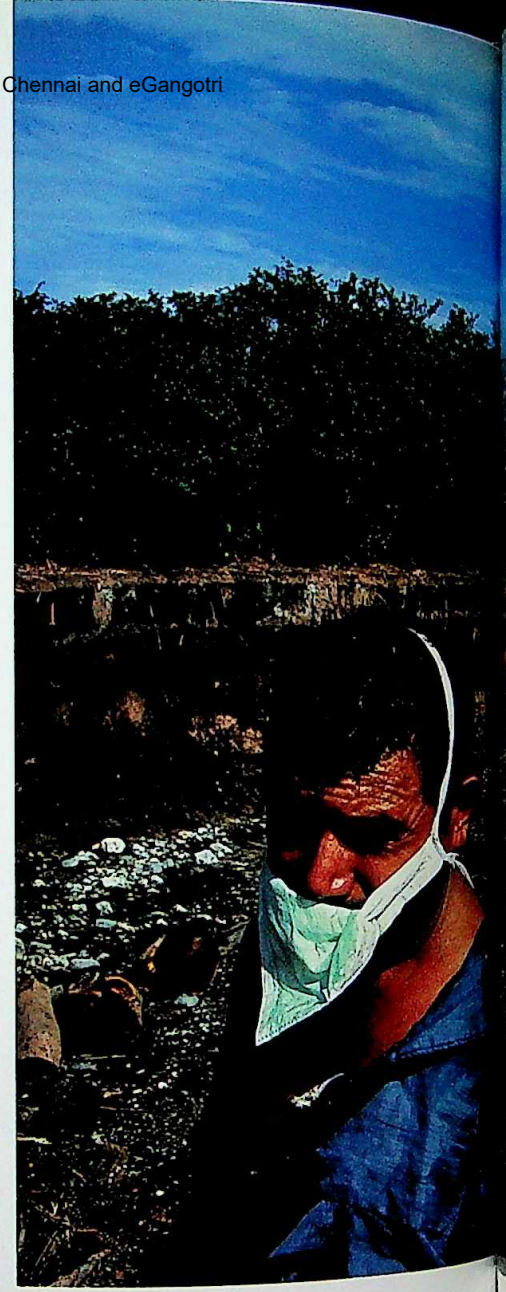
"The mountain just exploded. I saw everything coming but couldn't move. The mud was like quicksand, sucking me right down. I moved my legs as if I were climbing stairs and finally got myself out at five that evening. I must have looked like a monster. My face was all scratched, and I was sobbing because I thought I had lost my mother and all my brothers and sisters."

Paula took me around the shelter, introducing me to the others: a man who had lost his parents, his wife, and his three children; an orphaned boy with only his grandmother to care for him; a young woman who figured that 20 had died in her extended family.

In the room she shared with about a dozen others, Paula showed me her cot, neatly made up with a white sheet. She touched the neighboring cot, pushed up against hers. "This is my mother's," she said softly.

Three months after my initial visit, I made a second trip to Nicaragua and Honduras to find out how people were coping and how they were beginning to rebuild their lives. When I saw Paula and María again, they were still side by side. They had moved to a village called Los Charcos, where María's father lived, about 20 miles from Rolando Rodríguez as the macaw flies and out of sight of the Casita Volcano. María was visiting a friend in a wattle-and-daub, thatch-roofed hut with no lights or running water. She was nursing her new son, Jason. Paula was standing beside her, and Yarling and Jessica were playing close by.

"I'm staying here," María said. "I don't ever want to see that volcano again."



In the path of a massive avalanche of rain-soaked earth that killed some 2,000 people in Nicaragua, volunteer Dionisio Rodríguez Rizo pauses after burying bodies found near his village. Several miles in the distance a scar on the side of the Casita Volcano reveals the origin of the deadly slide. A simple cross marks one muddy grave (left).

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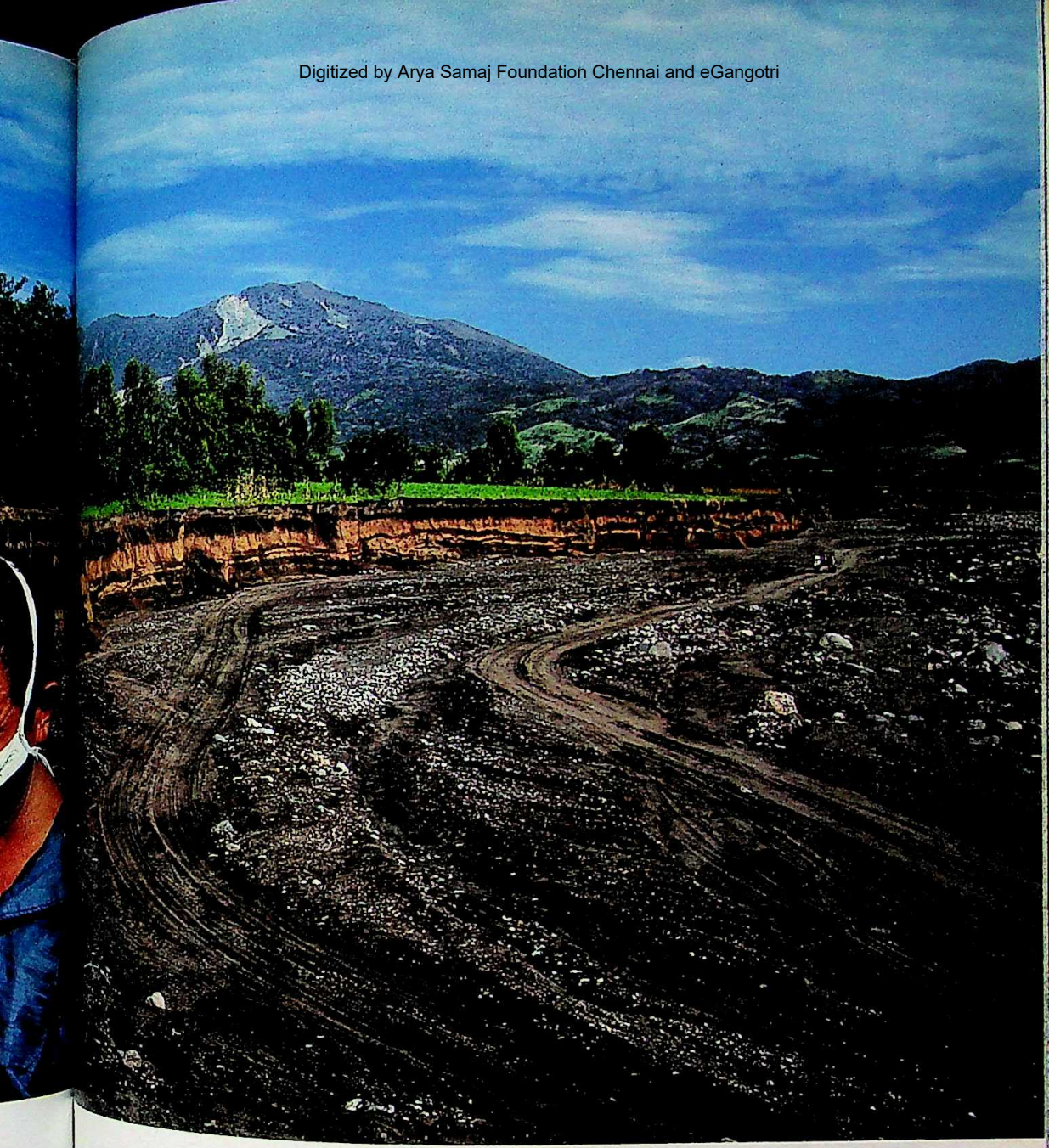

REPAIRING NORTHWESTERN Nicaragua —the most seriously afflicted part of the country—will be difficult, but the six million people of neighboring Honduras must deal with destruction across their entire territory.

"This hurricane walked all over us," said Ricardo Agurcia Fasquelle, an archaeologist who helped coordinate relief efforts. "Every major urban center was trashed."

Sustained winds of 180 miles an hour put Mitch in the rare Category Five, last used for Gilbert in 1989. Slowing slightly, Mitch stripped Guanaja, an island off the north coast, and then moved south, dumping several feet of rain in just a few days. Homes and businesses concentrated in the river valleys between mountains were flooded, and more than 5,000 Hondurans drowned or died in landslides. Tens of thousands of acres of land were swept away or buried too deeply to be farmed. At least a thousand miles of roads and more than a hundred bridges were left impassable.

In the Sula Valley in northern Honduras the visible damage included almost 25,000 acres of banana plants, toppled by rivers that broke through levees six feet tall and 30 feet wide. "Their force was unstoppable," said Arnaldo Palma, general manager of Chiquita's 16,000-acre operation in Honduras. Writing off 73

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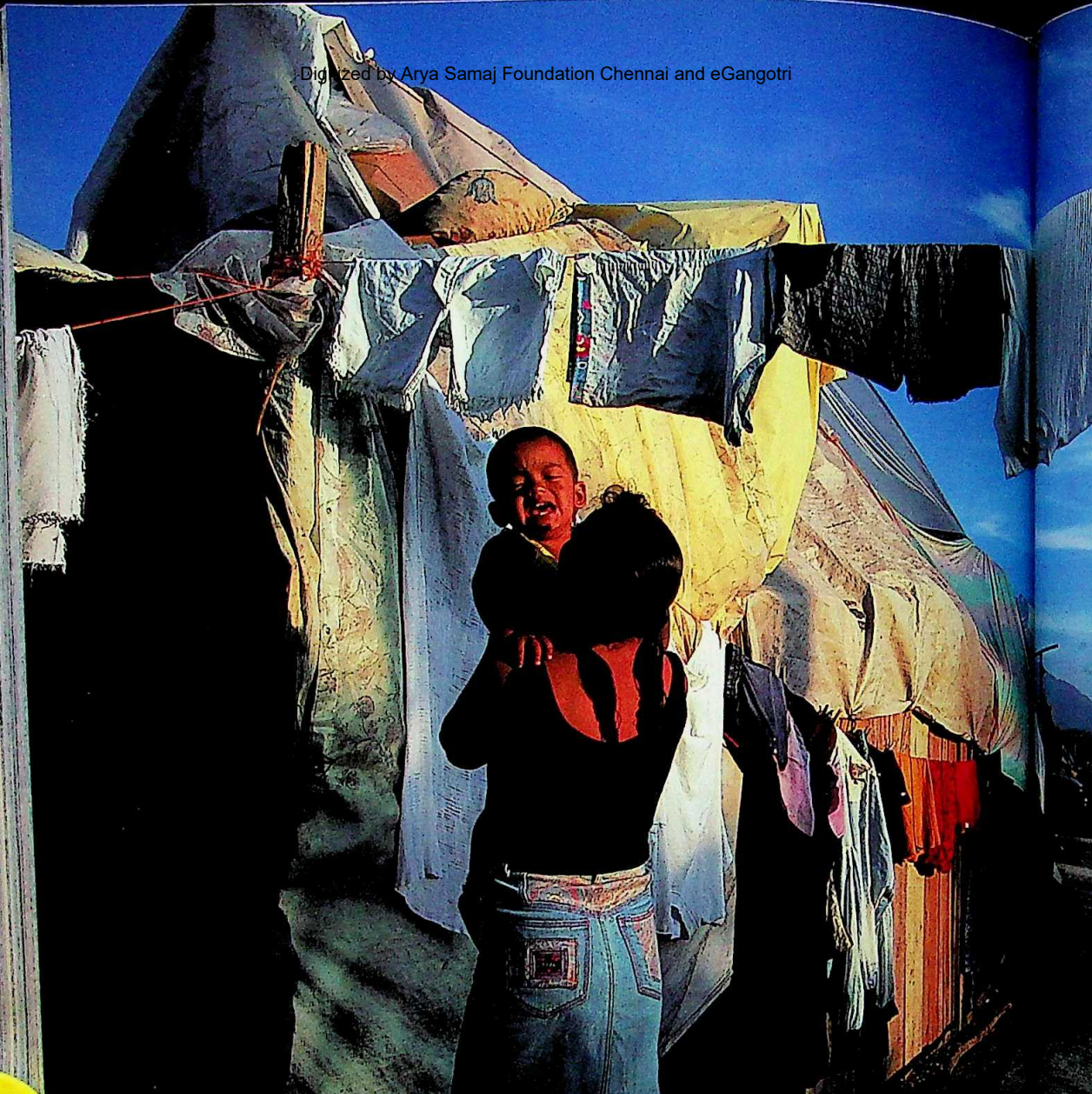

Waiting for her flooded home to dry out, Gladys Mejía cares for her son in a tent city built hastily on a highway in Honduras. "That was the only place not underwater in the whole La Lima municipality," says a neighbor.

million dollars in lost fruit and damage to equipment, roads, and levees, Chiquita has begun to repair and replant its flooded fields.

"This is going to be a hard year for banana workers," said Palma. Most of the company's 7,300 employees have had to look for temporary jobs to supplement loans from Chiquita and garden plots the company has let them use to tide them over until banana production begins to rebound—by mid-2000, Palma hopes.

"The total damage to Honduras was five billion dollars, and our national budget for 1998 was 1.1 billion," said Germán Pérez D'estephen, a director of the Chamber of Commerce in the industrial city of San Pedro Sula. "The math is simple. If we don't get help from abroad over the next ten years, it will take generations to get back to where we were."

Help began arriving right away. Mexico sent army troops and bulldozers. The U.S. military flew food, clothing, and medical supplies to remote villages and began to rebuild bridges. A group of Cuban doctors and nurses gave

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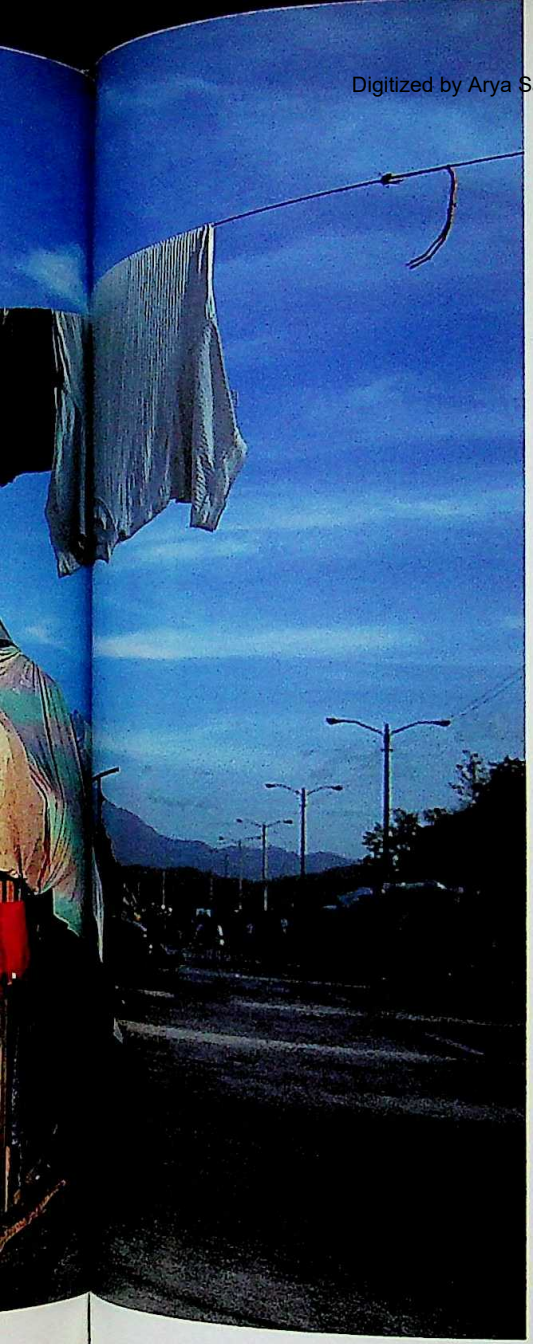

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victims medical care, and Red Cross volunteers from home and abroad installed water purification plants and built new homes. Japan's defense force, working outside its home country for the first time in a relief effort, helped with cleanup and reconstruction. Private citizens affiliated with churches, schools, and service organizations came from around the world to pitch in wherever they could. In addition, individual countries, development banks, and international organizations such as the United Nations pledged hundreds of millions of dollars in aid.

Putting all this assistance to work, explained Mary Flake de Flores, Honduras's first lady, will take time. "People are expecting this to happen sooner than it can. They don't understand that governments and banks just don't send 20 million dollars. To get that money, you have to present a project with every cost listed and the process of rebuilding explained."

As the Honduran government began sorting out the offers of aid, drawing up project proposals, and negotiating for forgiveness of its 4.5-billion-dollar international debt, people accustomed to being self-reliant began to put their communities back together.

FOR THE NEIGHBORHOOD of Martínez Rivera that meant shoveling mud. Spread along the Chamelecón River near San Pedro Sula, its metal-roofed homes of cinder blocks and wood are flooded almost every year in hurricane season, from June to November. "We're working people—maids, tailors, bricklayers, factory employees. We moved onto this land in 1990 to build our own houses because we couldn't afford to pay

"THE MATH IS SIMPLE. IF WE DON'T GET HELP . . . IT WILL TAKE GENERATIONS TO GET BACK TO WHERE WE WERE." — GERMÁN PÉREZ

rent anymore," said Exequiel Galo Osorto, vice president of the *patronato,* the community's governing body. "It belonged to the Chiquita banana company, and they let us stay." He and his neighbors have learned to live with the rhythm of the waters.

"We're not afraid, because the river speaks to us," said Manuel Cardona, the leader of a marimba band. "When it rises, it pulls the water hyacinths out of its banks. We see them float by and know the river is telling us to get out." The 500 or so villagers then hoist their smaller pieces of furniture to the rafters, climb the adjacent concrete embankment to a four-lane highway, block off two lanes, and set up shelters of plywood, tarps, and cardboard.

Usually the water recedes in a couple of weeks, and everyone returns home. But this time the river left several feet of mud behind.

"If we have to dig out on our own, it will take about eight months," said Exequiel, who talked fast and walked faster as he guided me

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TREACHEROUS SLOPES

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An entire neighborhood slumped downhill in a landslide that blocked the Choluteca River in Tegucigalpa; adjacent areas could go at the next heavy rain. All across the region weak, weathered soils continue to pose similar hazards. "I don't know if we will ever count them, but there were probably more than a million landslides created by this storm," says Bruce Molnia, a geologist at the U.S. Geological Survey.

Digitized by Arya Samaj Foundation Chennai and eGangotri

through the drier parts—only ankle deep in muck. "We want the government to lend us bulldozers to clear the streets. We'll do the rest. We don't have any money to rent machines like that, but we do have lots of strong arms and a willing spirit."

We passed evidence of that: a woman in a red skirt and black rubber boots who was trying to sweep the slop from her house, though it kept oozing back. Her name was Estela Rosa Ramírez, and she displayed remarkable equanimity. "As you can see, the floor is still wet. I guess I'll start washing down the walls," she said simply, before turning to cook some tortillas over a wood fire.

Three months later the bulldozers had come and gone, and most of the people of Martínez Rivera had moved back into their houses. Washing hung from lines, and sofas were drying beside pink-flowering hibiscus bushes. "Mitch is history," said Exequiel, as he and a crew of women cleared trash from their former campsite. "It's time to get on with our lives."

In an effort to encourage people to leave such vulnerable areas and to resettle those who had lost their homes, the government of San Pedro Sula was planning a new model neighborhood. With help from the Inter-American Development Bank, it had bought nearly 200 acres of land a 20-minute bus ride to the southwest. Each of 4,000 families who wanted could buy a lot of roughly 50 by 30 feet and the materials to build a kitchen, one room, and one bath. These houses would cost 35 dollars a month for 20 years; additions could be made if families could find the extra money.

"WE DON'T HAVE ANY MONEY TO RENT MACHINES . . . BUT WE DO HAVE LOTS OF STRONG ARMS AND A WILLING SPIRIT." — EXEQUIEL GALO

But that was hard to imagine. For those lucky enough to have full-time jobs, the minimum wage in the area—the least impoverished in Honduras—is about $80 a month. Seventy percent of the people live below the poverty line and have no savings. The only people I found in Martínez Rivera who said they would like to move were two elderly women who thought that the government was giving away land and that I was writing down the names of everyone for the giveaway.

"I'm staying right here," said Exequiel Galo. "I've invested sweat and sacrifice, and no one will reimburse me for that. It makes more sense to fix up what I own than to take a chance on buying something new." Stacks of lumber filled his front yard, and fresh clapboards framed his front door.

Taking on house payments now, with the national economy knocked almost flat, would be especially risky. "Last year we had a 3 percent growth rate. This year we expect a negative 3 percent," said Germán Pérez of the San Pedro Sula Chamber of Commerce. "Agriculture makes up three-quarters of our exports, and that was the sector affected most severely—bananas, coffee, shrimp, melons."

Leaving San Pedro Sula, I followed the path of destruction south to Tegucigalpa, the Honduran capital, where the homes of nearly a million people fill the valley of the Choluteca River. "We never imagined a hurricane would hit here," says Ricardo Agurcia, the archaeologist, who splits his time between the city and the Maya site of Copán. "At 3,000 feet, surrounded by mountains, we thought we were protected." But valleys anywhere are vulnerable: In 1974 Tegucigalpa suffered its share of the trauma associated with Fifi, a hurricane responsible for as many as 10,000 deaths in Central America.

With Mitch, dams overspilled or burst on rain-swollen tributaries, and the normally tame Choluteca became a monster. Sweeping boulders and trees along in its path, it damaged most of the city's 18 bridges and demolished entire riverside neighborhoods.

One of those was Miramesí, the home of 250 working-class families. Late on the night of October 30, as water began to surge through the streets, community leaders went door-to-door rousing people and helping them get to higher ground. An hour and a half later most of their homes were gone. In other parts of the city hundreds drowned in their sleep, but not a single person died in Miramesí.

"That was the best moment of my life, when I led all those people to safety," said Raúl Reyes Zúniga, the community president. A young man with an old-fashioned sense of responsibility, he was among the last out of Miramesí.

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DRASTIC CHANGES

Leaving a bridge high and dry six months after its inauguration, the Choluteca River takes a new route; during the storm it ran wider than normal by more than half a mile. Nearby, in what was a residential area of the city of Choluteca, scavengers collect firewood washed in by the floodwaters.

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Raúl took me back to the old neighborhood in his orange pickup truck, the only thing he was able to save. Most of the site was still covered in stagnant, fetid water. A small dry section was scattered with broken bricks and roof tiles and the things of everyday life—a shoe, a doll, a refrigerator shelf. A few houses remained on a hill, and people were living in them, including Alva Felipa Moncada, a mother of five and grandmother of three.

Alva had fled with everyone else, but faced with having to spend months living in one of the local churches—a crowded, uncomfortable shelter—she had returned to Miramesí and moved in with a friend. "I'm afraid of more flooding, but what else can I do?" she asked. "There are no apartments to rent, and I can't afford to buy a house."

Housing has always been expensive in Honduras because the price of land is so high—farmers, business owners, and homebuilders all compete for the same limited level acreage in this mountainous country. After Mitch left 10,000 people needing new houses in the capital alone, land was like gold.

Families in Miramesí had been together for generations and were determined to relocate as a community. When they approached the city government of Tegucigalpa for help, however, it seemed there was no one willing or able to make even the smallest decision. The number of flood refugees, the extent of the damage, and the death of César Castellanos, the city's popular mayor—whose helicopter crashed during a damage-assessment flight—had created an overwhelming sense of paralysis.

As time dragged on and people in the shelters began to think about finding homes individually, Raúl Reyes and the other leaders of Miramesí decided to try to get land on their own. With the help of Michael Miller, a teacher from Missouri working to rehabilitate drug-addicted street children in Tegucigalpa, they put up a Web page and e-mailed appeals for money around the world.

"Donations came in dollar by dollar," Michael told me. "A Girl Scout troop in Atlanta sent $50. A senior citizens group in Houston sent $100. A fund-raising campaign in the Netherlands contributed $7,000."

The money was enough to buy 18 gently rolling acres on a bus route just six miles from the city, safely removed from future flooding of

"Land is the most important thing for us to have. Houses we can put up on our own," says one of the homeless people crowding in with ID cards to sign up for a private land deal near Choluteca. Two thousand families vied for 600 spacious lots. In a public project, where yards are much smaller, refugees work on one of 50 houses being built with materials donated by a U.S. church.

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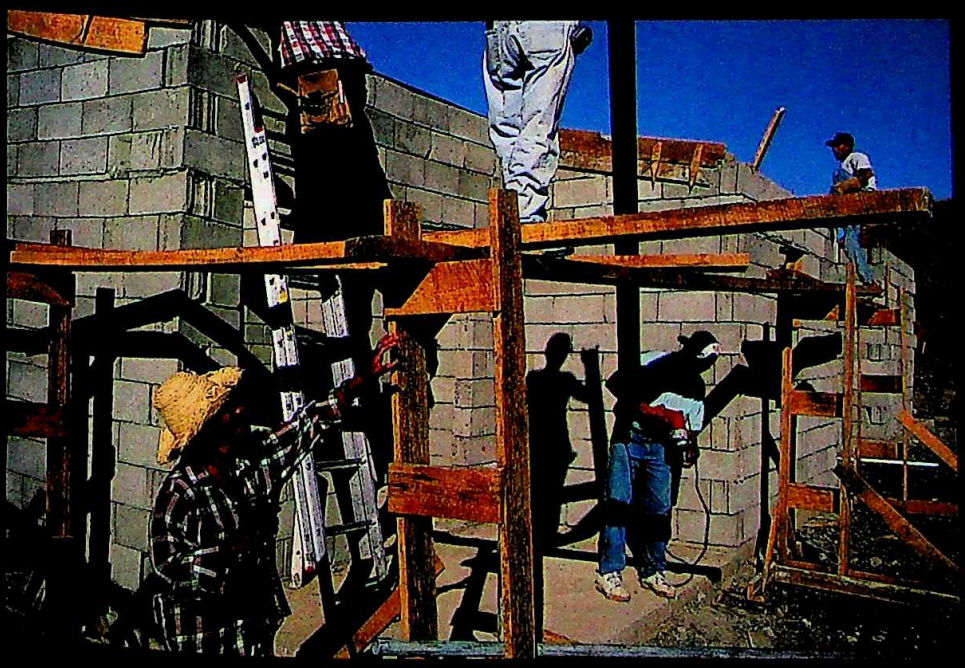

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EMERGENCY MEASURES

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With more than a hundred bridges washed out, getting around in Honduras has not been easy. At the Bonito River local workers lay a concrete footing for a temporary steel bridge that U.S. Marines put up to carry one lane of traffic until a more substantial structure can be built. Meanwhile bikers, pedestrians, and motorcyclists use a suspension bridge of rope cables and wood planks; cars and trucks drive across a ford downriver.

Digitized by Arya Samaj Foundation Chennai and eGangotri

the Choluteca River. The original asking price for the land was $50,000, but when the three owners found out who wanted it and why, they lowered the price to $41,000. "They're good Christian people," Michael said.

On the first Sunday in February the Miramesí settlers arrived early to clear brush and thorny acacia trees from their new neighborhood, men and women alike working under a cloudy sky, swinging their machetes, fueled with the energy that comes with hope. "We see now that the Lord hasn't abandoned us despite all we've suffered," said Carmen Valladares, whose gray hair was tucked under a black baseball cap. "This place is beautiful."

"THAT RIVER STOLE THOUSANDS OF ACRES OF GOOD FARMLAND FROM US . . . . IT'S A REAL TRAGEDY."

— LITO CASTILLO

From Tegucigalpa the Choluteca flows north, then south and west to the Pacific. Bloated with floodwater and debris picked up en route, it struck the south coast with such force that it transformed the landscape—a process of eons speeded up to hours. In the city of Choluteca the river grew to more than ten times its normal width. Dumping tons of stones and sand on its new banks, it turned residential areas and melon fields into wastelands. Scouring away neat rows of ponds on shrimp farms, it created a new channel, where perhaps a third of its water ran during the storm.

"That river stole thousands of acres of good farmland from us," said Lito Castillo Galo, a business leader who surveyed the damage from the air. "Only 14 percent of Honduras was arable to begin with, so it's a real tragedy."

Before the storm more than 500 shipping containers had been lined up at the entrance to the city, ready to receive the season's first harvest of cantaloupes, honeydews, and watermelons. Some of those containers were now scattered at the river's edge, and one was wrapped around a tree; others had been deposited in fields almost 20 miles away.

"This is, let's say, our graveyard," said Arnon Faroud, the Israeli manager of the melon company Suragrícola de Honduras, the region's largest employer before the hurricane, with 12,000 on its payroll. He took me on a tour of the company's operations, driving past field after field where the waters had destroyed melons ready to be picked, ripped out irrigation tubing, and buried tractors in mud and stones.

Because so much farmland was lost here in the south—either buried under several feet of debris or washed away—Suragrícola didn't have enough work for all its employees. The hurricane's effects on his company, Arnon explained, were rippling even further through the economy. "The people we rented land from won't get their money, and the bank won't get its loan payments. It affects everyone."

Juan Custodio, the manager of a tire store on the highway through Choluteca, said his sales volume was off by 70 percent. "The melon farmers who are out of work need tires for their pickup trucks, but they have no money, so our business is suffering too," he said. "Only God knows what will happen."

At one point on our tour Arnon stopped at the jagged edge of a cliff above the Choluteca. A brand-new bridge, built with Japanese aid, stood a quarter of a mile away. It had no approaches: At both ends the flooding had swept away whole sections of road as well as the surrounding farmland. "Every time I see this, it's just incredible," he said. "I'm having to change all my standards of what a disaster is."

Downtown Choluteca hadn't experienced anything like Mitch in at least a hundred years—the age of many of its adobe buildings, which melted away in the raging water. As I picked my way along mud-choked streets, several teenagers walked by with shovels over their shoulders. "We're going to dig out our school," they told me, so I tagged along.

At the school, the Instituto Superación, students were already taking mud from two internal patios—in wheelbarrows, on pieces of plywood, and by the shovelful—and dumping it in the street. "Hard work and hope are all we have," said Maribel Rodríguez de Rivas, the school's irrepressible guidance counselor.

By the time of my second visit, the school's flood-weakened facade had been replaced by cinder blocks, and workmen were installing a new tile roof. Classrooms and offices, where the mud had been several feet deep, had fresh coats of paint. And the acacia trees in the patios

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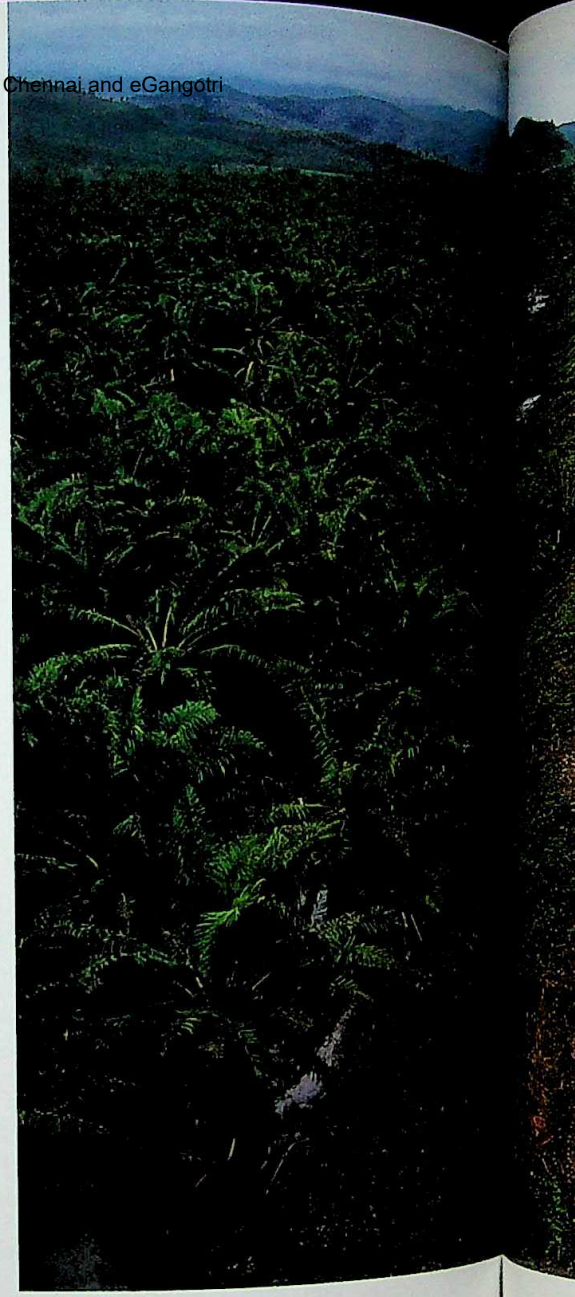
AGRICULTURE SMASHED

Rivers that broke through levees and engulfed farms in northern Honduras left a lake of flattened plantains (below). In a drying banana field, laborers salvage irrigation pipes. Chiquita, their employer, lost 16,000 acres of bananas. Other cash crops such as coffee and melons were also devastated.

Digitized by Arya Samaj Foundation Chennai and eGangotri



Miles of highway near Trujillo—and throughout the rest of Honduras—still need repair. "There's no way we can recover quickly from something this serious," says a Tegucigalpa businessman. "We're going to be fighting our way back for years."

had been pruned to let in the hot, drying sun. "We're a private institution, so the government won't help us," Maribel said. "We've had to take out a bank loan to fix everything."

For Maribel, acquiring a loan to repair her own home a few blocks away was impossible. "I need $25,000 to put it right, but with interest at 24 percent I'd have to repay $300 a month. I can't afford that now," she explained, as we walked down a street still flanked by heaps of drying dirt, our footsteps sending up yellow clouds of dust. "Because of the economy, we've lost half our students, so I'm only getting half my salary—$260 a month. I'll just have to let the repairs go for a while."

The adobe front of her house had dissolved into lumpy earth, but the solid, stuccoed rooms at the back stood firm, and she had bricked up the doorways to keep out prowlers. Half a block away two men were replacing a wall at her mother's house, where Maribel was staying. Her family wasn't about to give up.

Nor was Arnon Faroud's melon company. Fields had been replanted a safe distance from the river, and Suragrícola de Honduras was shipping its first post-hurricane crop to the winter-chilled United States. When I stopped by one evening, Arnon was at work at a packing plant awash in cantaloupes; they were rolling out of trucks into chlorine baths, out of the baths into sorting machines, and out of the sorters into boxes. "We have too many melons now," he said with a laugh. What he meant was that he had too few shipping containers, because so many had been lost in the flood.

"We lost 2,000 acres of land forever in that storm," he said. "We'll produce about 70 percent of what we did last year, but that's only because the owners of the company were willing to reinvest."

As Arnon filled a box with melons for me, I remembered something he had said in our first meeting about the way the people of Choluteca were tackling the aftermath of Mitch. It struck me as true of what was happening all over Honduras. "Individuals and companies made decisions on their own that they never would have in a developed country. Privately owned tractors and backhoes from shrimp farms worked around the clock to fix roads. And without any outside direction we had electricity from generators in just a few days. That shows this is a place people can be proud of."

As admirable as everyone's efforts have been to help the region recuperate, the fact remains that lives have been changed forever. Carlos Valdivia Camas, a friendly 30-year-old farmer, lost his entire 29 acres and most of his family in the Casita mudslide in Nicaragua. "We were going to be living so well this year," he told me

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in the shelter where he was staying in Posoltega. "The harvest was wonderful, and we had plenty." Now a framed color photograph of his mother was the only thing he had left.

Like his neighbors, Carlos had no money and no prospects for a job. "Farming is all we know," he said, "and there's no other work available anyway." With no way to help himself, he was waiting to move onto one of the small plots the local government had been able to buy for hurricane refugees.

One afternoon I went with Carlos to look at the site. It was less than half the size of his ruined farm, but 150 families were supposed to live there on lots staked out at 100 by 30 feet. Above us was the scarred face of Casita. "We'd be right in front of the tiger that bit us," he said. "And how would we farm like this? Even if I have a house here, I'll have to look for a job someplace else."

People he knew were already cleaning houses in Managua and picking coffee in Costa Rica. I wondered if, like them, he would stay in Central America—or join the thousands of other refugees hoping to find better prospects in the U.S. Whatever future Carlos Valdivia makes for himself, one thing is certain: He will never escape the memory of the hurricane. □

For links to organizations providing relief to storm victims, go to *www.nationalgeographic.com/ngm/9911.*

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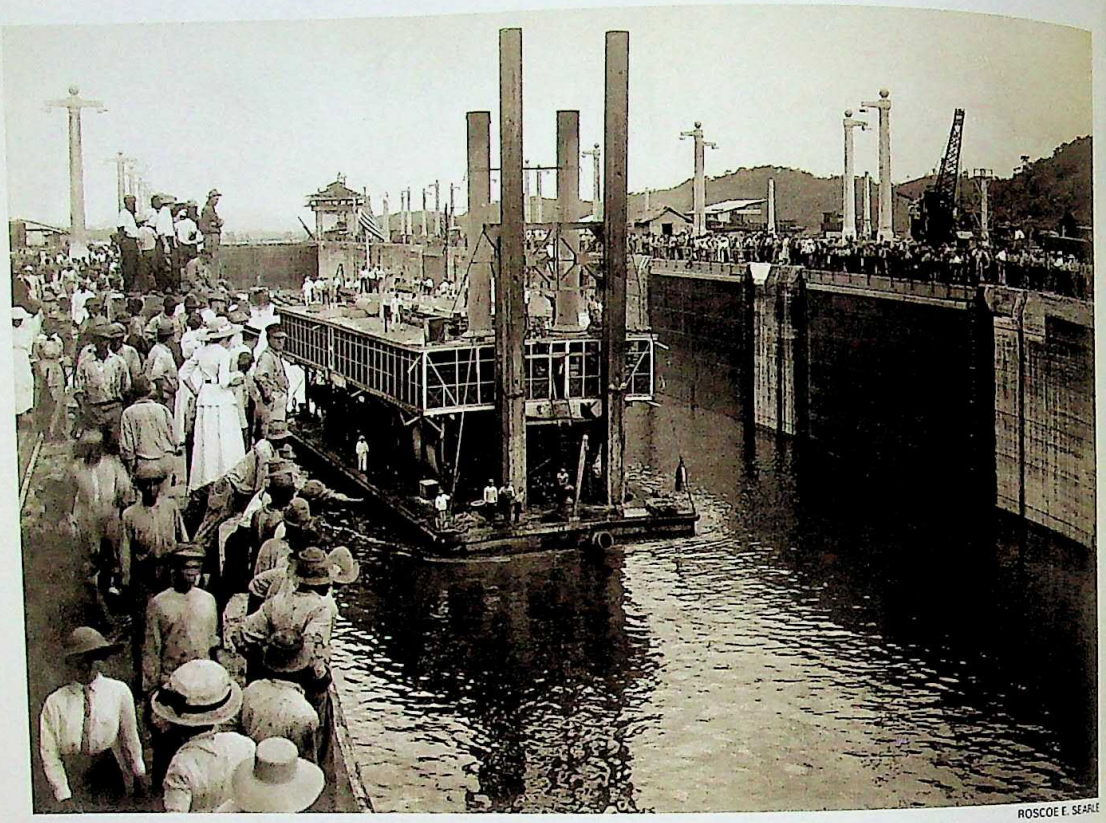

ROSCOE E. SEARLE

■ FROM THE GEOGRAPHIC ARCHIVES

A Man, a Plan, a Canal: Panama

"There might be both a congress of nations and a congress of mosquitoes on the Isthmus," wrote staffer William Joseph Showalter in "The Panama Canal," the first of two GEOGRAPHIC articles he wrote on the subject. In February 1912 that piece ran unillustrated, but the photographs here and on the following pages—found in his office desk after his death in 1935 and never before published by the magazine—could have done the job.

The Panama Canal slices 50 miles through jungle to connect the Pacific to the Atlantic, saving ships sailing from New York to San Francisco 9,000 miles of travel around South America. Beset by malaria and bad planning, the French abandoned their hopes of carving a sea-level canal in 1898. Six years later the American government took on the project, introducing a system of locks. Cutting through the Continental Divide proved the biggest engineering challenge. A fleet of dredgers like this one (above) at Pedro Miguel Locks was kept busy pumping silt from collapsed hillsides.

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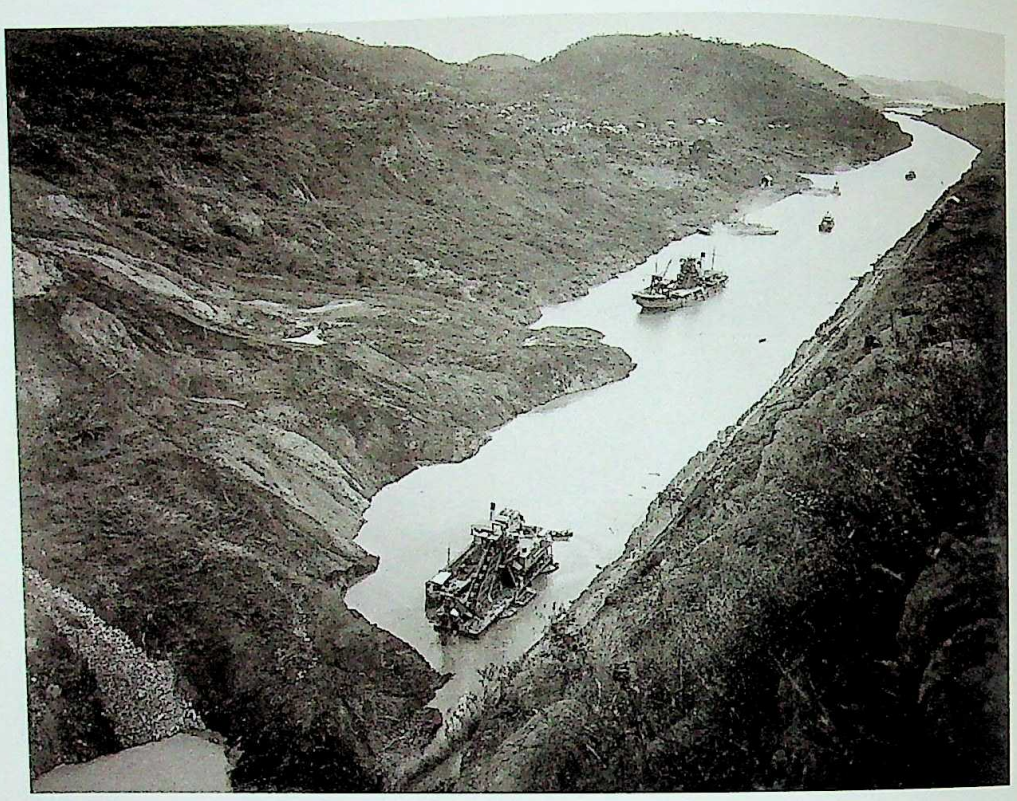
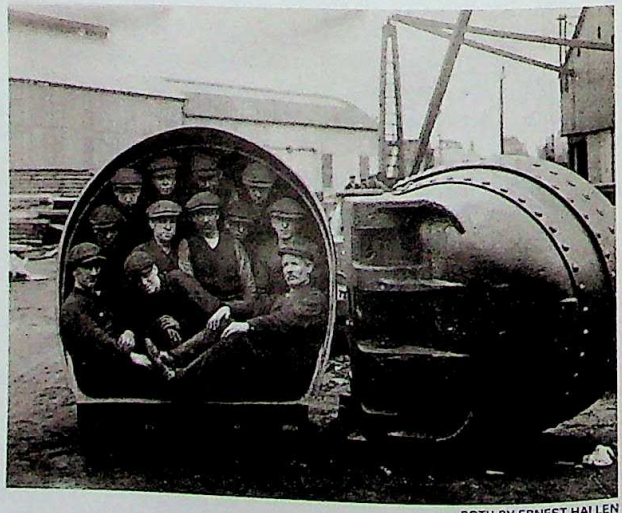


■ FROM THE GEOGRAPHIC ARCHIVES

Changing the Channel

Construction crews in 1913 had to clear frequent landslides (top) even after they completed Culebra Cut (later called Gaillard Cut) across the Continental Divide, finally making the Panama Canal navigable. In William Joseph Showalter's February 1914 article, "Battling With the Panama Slides," he wrote, "Some 19 million pounds of dynamite have been exploded in Culebra and enough material removed to make 26 pyramids, each as large as the Great Pyramid of Cheops, in Egypt." Work like that took a big shovel: A dozen men fit in the dredger *Corozal*'s "mud bucket" (below), which could dig 50 feet deep and carry 54 cubic feet of silt with each scoop.



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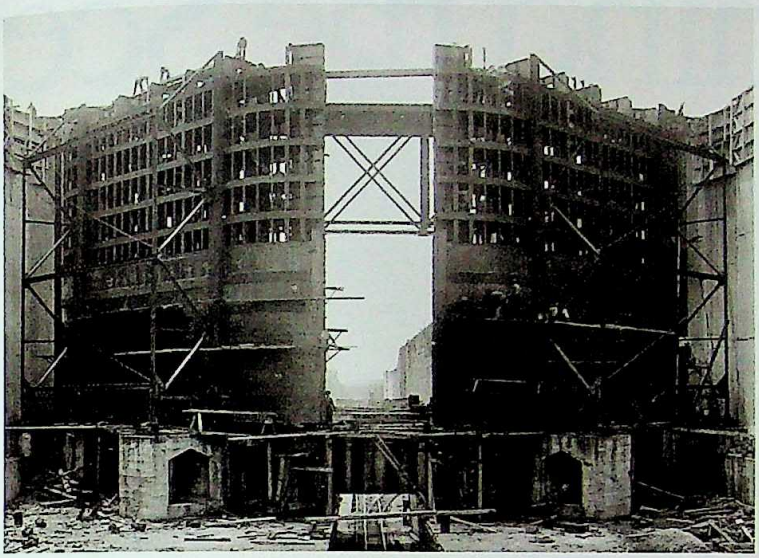

FROM THE GEOGRAPHIC ARCHIVES

Locked Up at Last

"At Panama they make artificial rock, and make it so fast that one scarcely can believe his eyes," wrote Showalter in 1912. Advances in concrete building technology made possible these 82-foot-high guard gates (above) at Gatún Upper Locks, photographed in 1911.

Spectators gathered along railroad tracks on October 10, 1913 (below), to watch workers dynamite Gamboa Dike, freeing the waters of Gatún Lake to flood Culebra Cut for its final dredging. Ten months later—after ten years of effort—the Panama Canal was complete.

BOTH BY ERNEST HALLEN

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Behind the Scenes

BOTH BY MARK THIESSEN, NGS

Calling on the Carpet

At age 51, Loren McIntyre—U.S. Navy officer, State Department foreign aid officer, and filmmaker—retired, only to start a new career. He became the Society's man in South America, writing and photographing articles and books on the continent over a span of three decades.

Loren's first GEOGRAPHIC assignment, on Bolivia, made the cover in February 1966. He took a copy of that issue to Ecuador on his second assignment, to help open doors. Bob Roberson, a carpet-factory owner he interviewed there, asked to keep the magazine. Loren reluctantly handed it over, not realizing he would see the cover again: on a four-by-six-foot rug (above) Roberson sent to headquarters a year later.

Unfortunately for Loren, a Society official intercepted the gift and claimed the carpet for his own office decor. The official retired, and the rug was eventually put in storage, where it remained until finally reunited with Loren for this photograph.

Thinking Globally

"They're completely redesigned, the best we've ever offered," says NG Maps' Kevin Allen of our latest illuminated globes (left). When he visited the German office of globemakers Columbus Verlag, Kevin realized our "new" association with the old family firm wasn't quite so recent. Framed on a wall was a 1960s National Geographic membership certificate belonging to the company president's grandfather.

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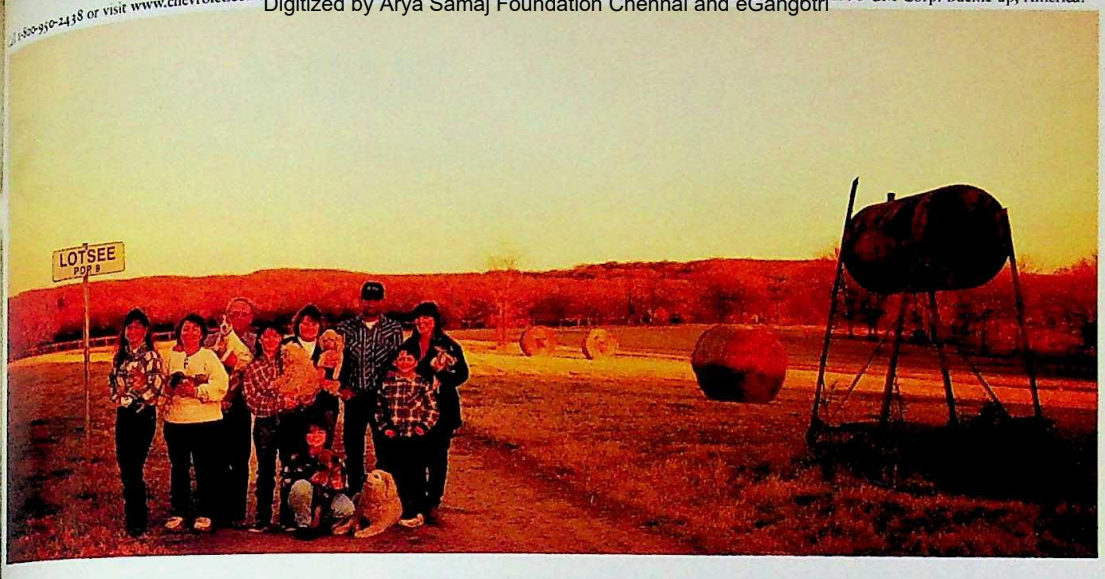

Lotsee, Oklahoma. Holds nine.

(The name comes from

the Indian word that means,

"Bright Child.")

The Chevy Suburban. Holds up to nine.

(The name comes from

the American word that means,

"Bright Idea.")

CHEVY SUBURBAN LIKE A ROCK

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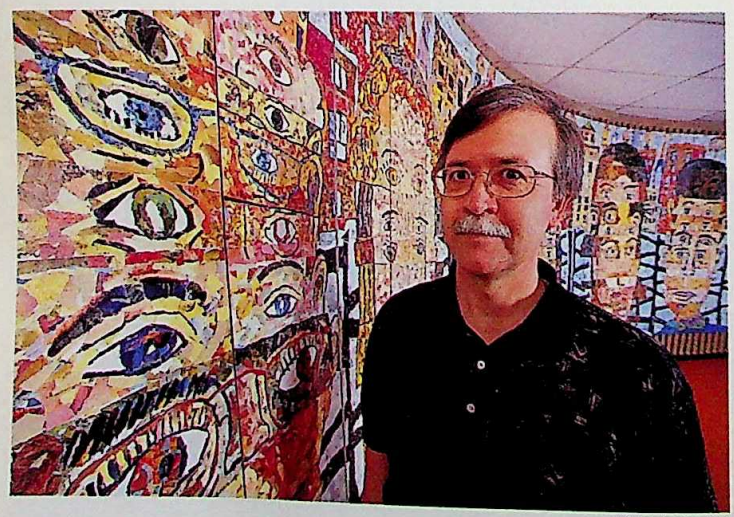
MARK THIESSEN (ABOVE RIGHT); FRANK HURLEY, ROYAL GEOGRAPHICAL SOCIETY, U.K.

Shackleton Lifeboat Docks at Explorers Hall

Memories of the lost ship *Endurance* live on at the Society's Explorers Hall this month in an exhibit on Sir Ernest Shackleton's Antarctic adventure, featured in the November 1998 issue. The show, organized by the American Museum of Natural History, runs until February 2000 and includes expedition photographer Frank Hurley's pictures, as well as belongings of the men who survived for ten months by eating penguin and seal and living under lifeboats after their ship was crushed by ice. The exhibit highlight is the *James Caird* (above), a $22^1/_2$-foot boat that carried Shackleton and five of his men on a desperate 800-mile journey to find help for the 22 men left behind.



KEVIN O. MOONEY

The Medium Is the Message

"I'm an artist and a social worker. I wanted to bring both things together," says Ferdinand J. Pleines (above). He planned this 23-foot-long collage celebrating ethnic diversity and founded Metromural, an organization that offers the mural as a traveling exhibit. The mural panels, created last year by 149 schoolkids in Aurora and Lincolnwood, Illinois, are made entirely of pages torn from old GEOGRAPHICS. But Pleines suspects that some young artists stretched the guidelines. "I found a picture of Leonardo DiCaprio on one panel. How'd he get there?"

Packing It to Go

After Hurricane Mitch hit Honduras last October, magazine business manager Teresa Lawrence (above) organized a relief drive for her hometown of San Marcos de Colón. Clothes were donated at drop-off points around the Society, and soon 26 boxes were off to Honduras. "I worried as I packed up. Some of the clothes were so big!" says Teresa. Where she comes from, folks run small. But her mother, who distributed the boxes in San Marcos, reports that extra-large clothes were put to good use—as bedding.

The Society helped sponsor a concert featuring fiddler Bonnie Rideout, then matched the proceeds. The result was $50,000, sent to Habitat for Humanity's Central American fund.

TEXT BY
MAGGIE ZACKOWITZ

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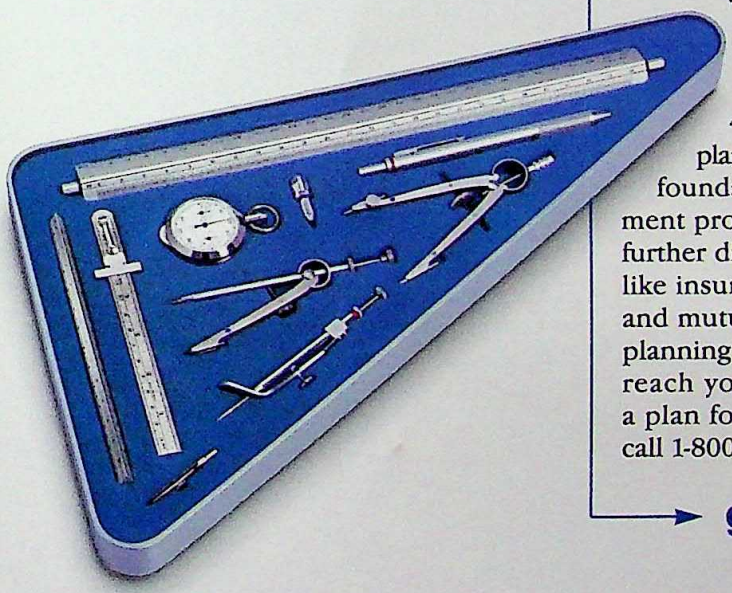

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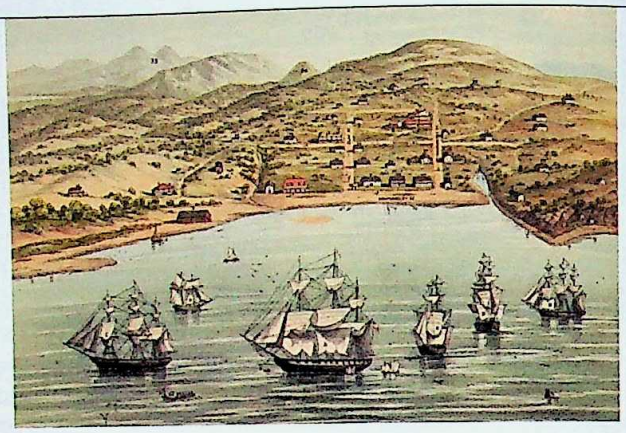

Panoramic Maps Depict 19th-century Urban Sprawl

One hundred fifty years ago this fall, gold seekers by the thousands were pouring into California in covered wagons and square-riggers. Although relatively few of the forty-niners actually struck gold, their arrival changed the course of American history—and transformed San Francisco almost overnight from a village to a metropolis.

The "bird's-eye views" shown here dramatize that change. The panoramic map above depicts San Francisco as it appeared shortly before gold was discovered less than a hundred miles from the port in January 1848.

At the height of the gold rush the city boasted an average of 30 new houses—and two murders—a day. By 1864 (below) the city had survived a series of devastating fires and sprawled across its famed hilltops.

In the decades following the Civil War, civic boosterism created a demand for urban panoramas, which local and itinerant artists were happy to satisfy. More than 2,000 American cities and towns were depicted in this fashion, from remote railroad stops on the High Plains to smoke-wreathed factory towns of the East. The panoramas provide a rich and beautiful record of America's growth from agrarian backwater to industrial powerhouse.

Some 1,700 of these maps reside in the vast collection of the Library of Congress. Fortunately, browsing this trove no longer requires a visit to Washington, D.C. More than a thousand city panoramas are on the library's "American Memory" website *(http://memory.loc.gov)*, part of an ambitious program that will eventually bring thousands more high-quality map reproductions to the Internet.

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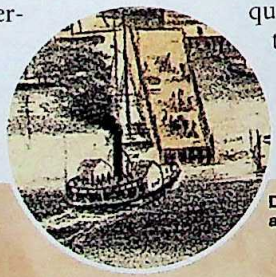
ALLEN CARROLL
Chief Cartographer



Detail at actual size

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Journey Into the Congo by Modem

Biologist Mike Fay is embarking on a yearlong walk into the forests of central Africa to gather population data—crucial to conservation efforts—on elephants and other wildlife. Fay will send dispatches to our website along the way. Join the expedition at *www.nationalgeographic.com/congotrek.*

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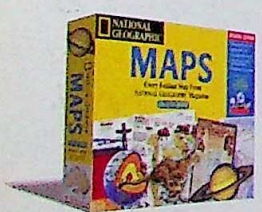

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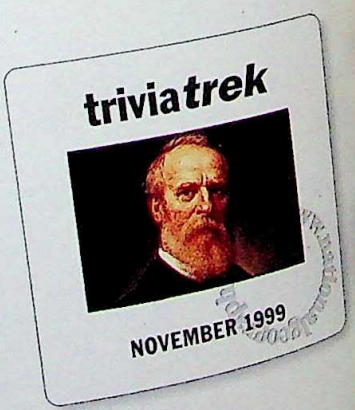

■ TRIVIA TREK

Got Lemonade?

This 19th-century U.S. President thought it "wise and useful" to ban alcohol from the White House, but critics derided the First Lady as "Lemonade Lucy." Who was he? Find the answer "Inside the White House," and tell us at . . . */trek.*

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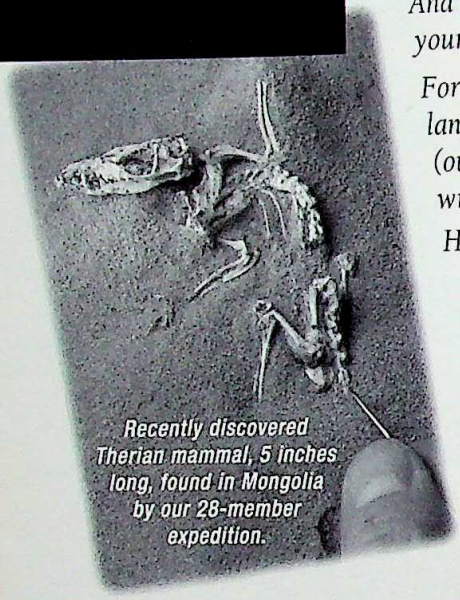

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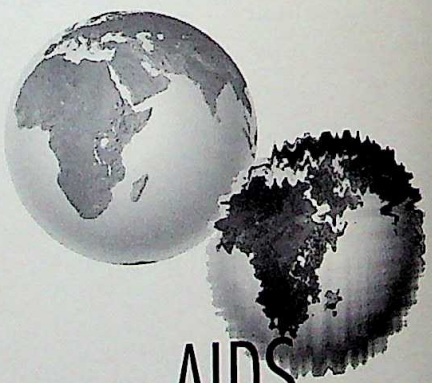

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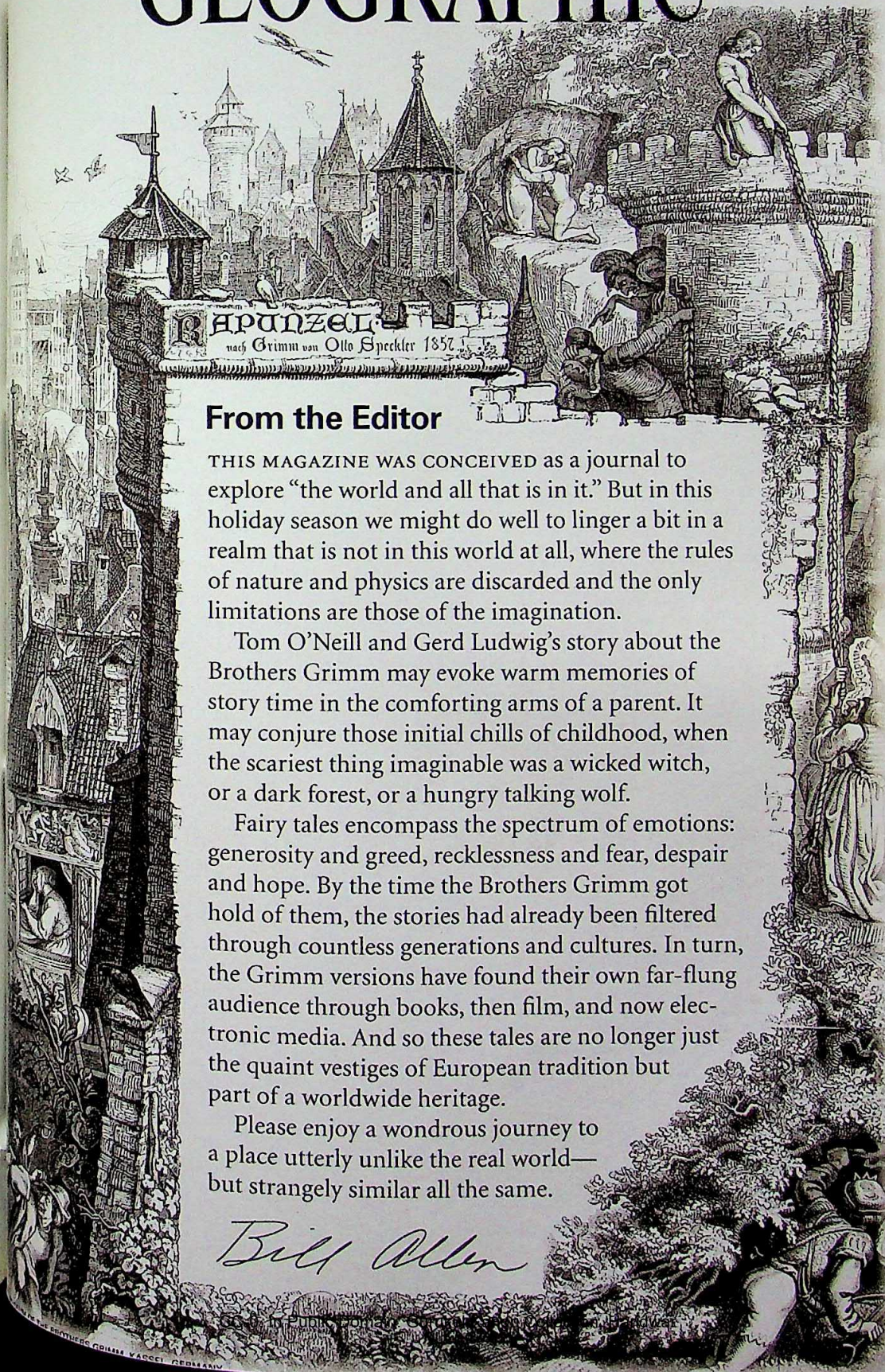

From the Editor

THIS MAGAZINE WAS CONCEIVED as a journal to explore "the world and all that is in it." But in this holiday season we might do well to linger a bit in a realm that is not in this world at all, where the rules of nature and physics are discarded and the only limitations are those of the imagination.

Tom O'Neill and Gerd Ludwig's story about the Brothers Grimm may evoke warm memories of story time in the comforting arms of a parent. It may conjure those initial chills of childhood, when the scariest thing imaginable was a wicked witch, or a dark forest, or a hungry talking wolf.

Fairy tales encompass the spectrum of emotions: generosity and greed, recklessness and fear, despair and hope. By the time the Brothers Grimm got hold of them, the stories had already been filtered through countless generations and cultures. In turn, the Grimm versions have found their own far-flung audience through books, then film, and now electronic media. And so these tales are no longer just the quaint vestiges of European tradition but part of a worldwide heritage.

Please enjoy a wondrous journey to a place utterly unlike the real world—but strangely similar all the same.

Bill Allen

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By RICHARD CONNIFF

Photographs by CHRIS JOHNS

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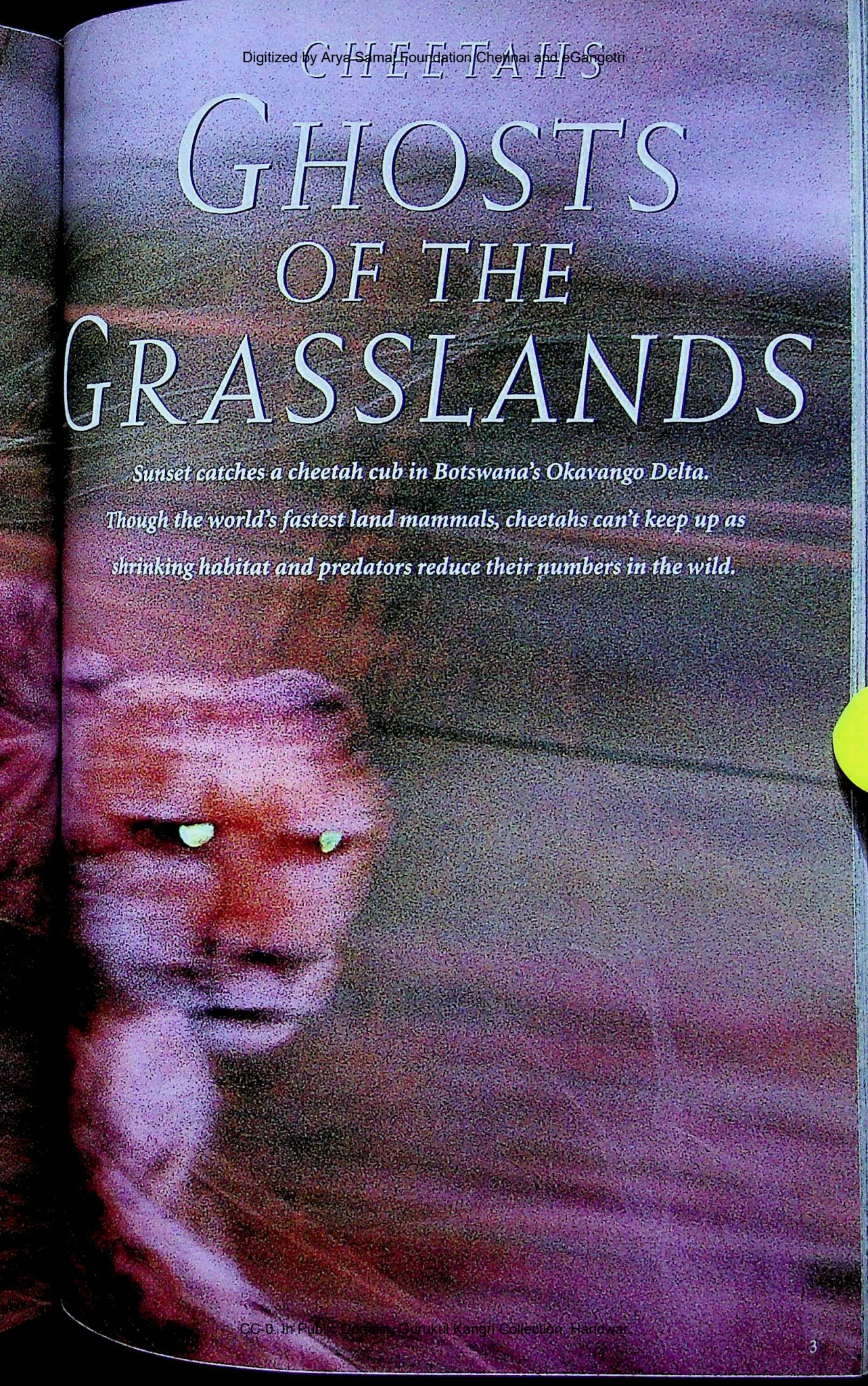
CHEETAHS

GHOSTS OF THE GRASSLANDS

Sunset catches a cheetah cub in Botswana's Okavango Delta. Though the world's fastest land mammals, cheetahs can't keep up as shrinking habitat and predators reduce their numbers in the wild.



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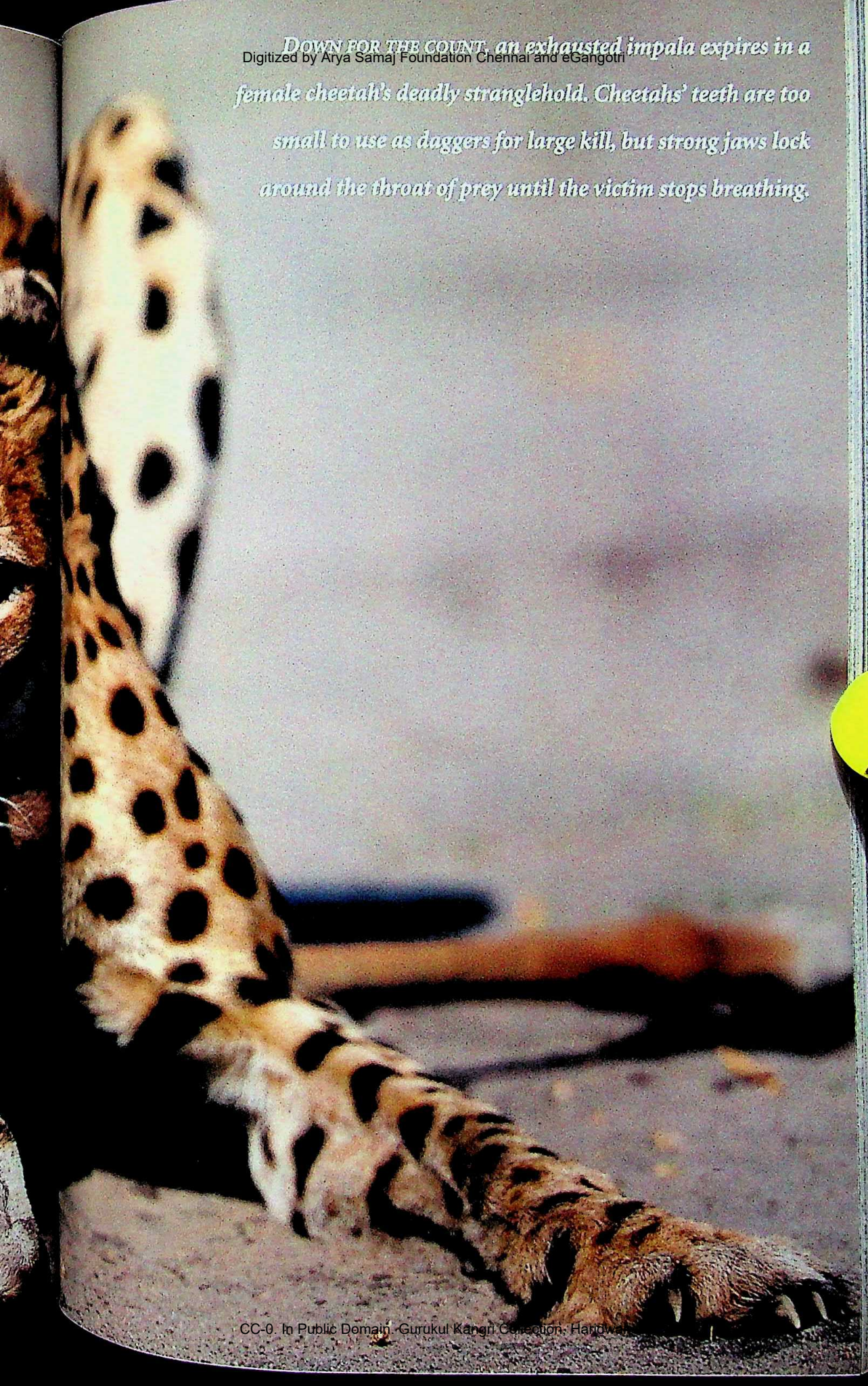

DOWN FOR THE COUNT, an exhausted impala expires in a female cheetah's deadly stranglehold. Cheetahs' teeth are too small to use as daggers for large kill, but strong jaws lock around the throat of prey until the victim stops breathing.

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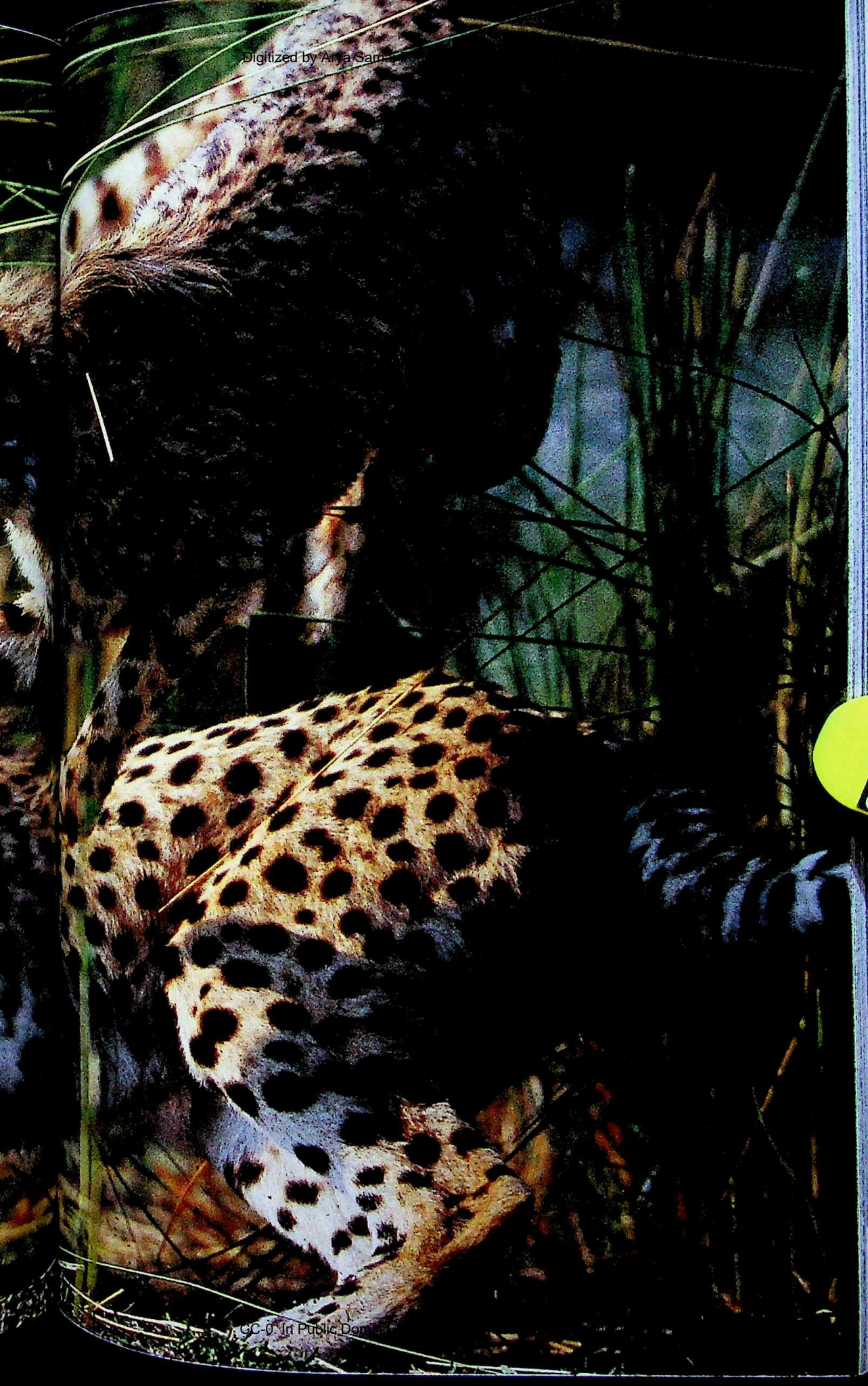
SURPRISE ATTACKS from the cover of tall grass are all in a day's play for 14-month-old cubs. Such behavior may teach young cheetahs the skills of survival in the wild—where in a few months they must fend for themselves.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IT WAS OPEN SEASON on babies in the Serengeti. Since mid-February the vast antelope herds had been raining down fawns on the rolling African plains. They were tender, glossy-eyed creatures on unsteady legs. Their mothers bedded them down under grassy tussocks and whistling thorn acacias, hoping they would go unnoticed until they were strong enough to run with the herd. All a cheetah had to do was meander around like a child on an Easter egg hunt, nosing under the vegetation till it found a treat. A seven-year-old named Talisker and her four cubs had just finished off a young Thomson's gazelle. Two of the cheetah cubs sat and rasped their long tongues up one another's cheeks, preening with pleasure. When they walked, biologist Sarah Durant studied their bellies through her binoculars. The cubs ranked a 9 and Talisker an 8 on the Serengeti Cheetah Research Project's belly-fullness scale of 1 to 14, with 14 defined as "swallowed a basketball" and 8 being about hungry enough to start hunting again. In the distance a column of sunlight broke through the slate-colored clouds. Talisker took up sentry duty atop a termite mound.

"There's a wildebeest calf over there," said Durant, as if hinting to Talisker. No one here roots for Bambi, except as Bambi tartare. Talisker soon spotted the calf, a tawny creature about the size of a horse foal, which had made the fatal error of becoming separated from its herd. The cheetah closed on the calf from the left rear flank at a trot, not bothering to stalk or slink.

When the wildebeest started to run, Talisker dug in behind. The two turned, the cheetah's great doglike paws kicking up clots of dirt and grass. The distance between them narrowed. Still running, Talisker reached out and swatted the wildebeest across the haunches with her forepaw, driving it down in a tumult of dust. The wildebeest struggled to its feet and reared up to shake off the demon now locked on its windpipe. Talisker went up on her hind legs and hung on. The four cubs came bounding up from behind and shoved the wildebeest back down again. They stood on its

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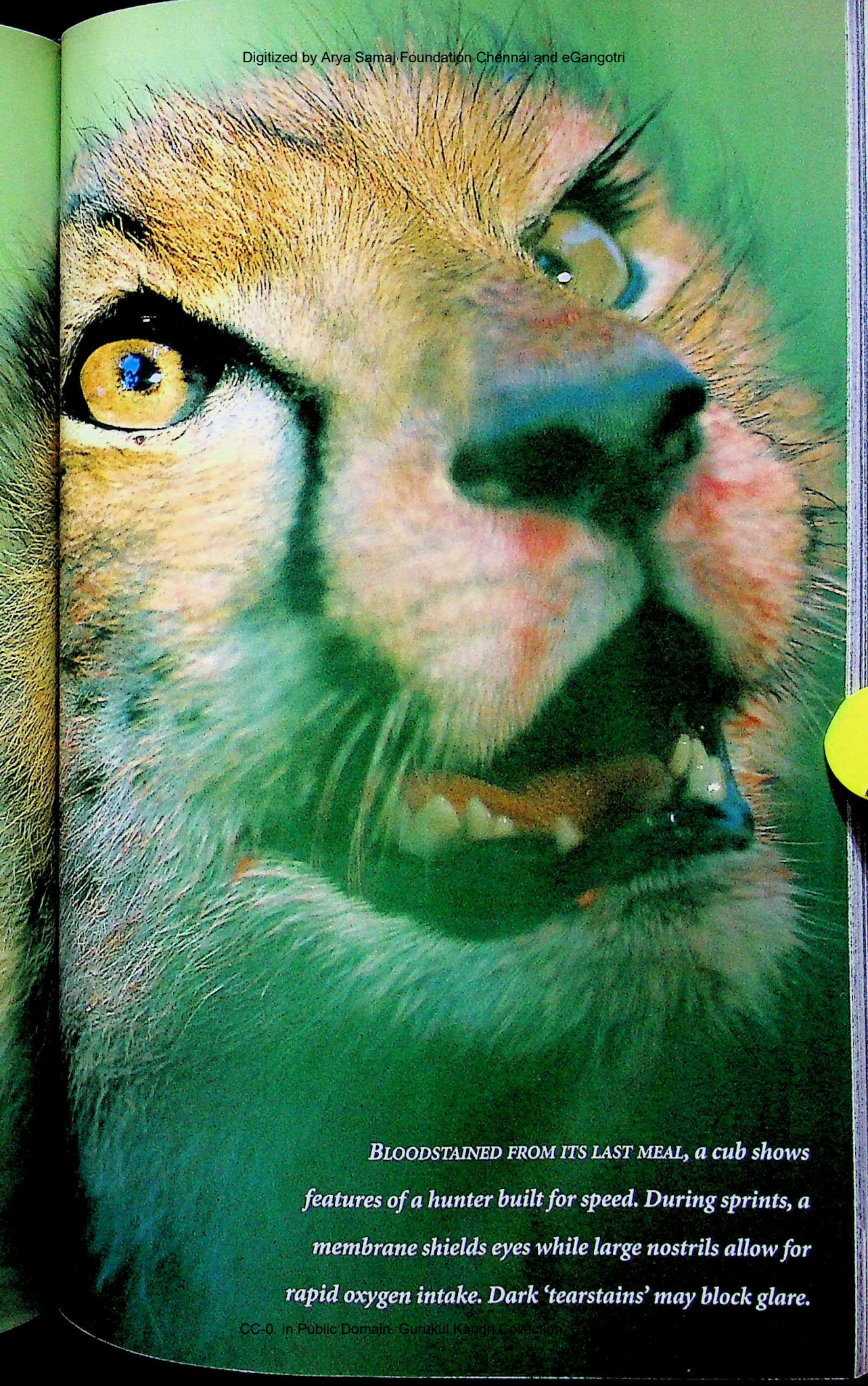

BLOODSTAINED FROM ITS LAST MEAL, a cub shows features of a hunter built for speed. During sprints, a membrane shields eyes while large nostrils allow for rapid oxygen intake. Dark 'tearstains' may block glare.

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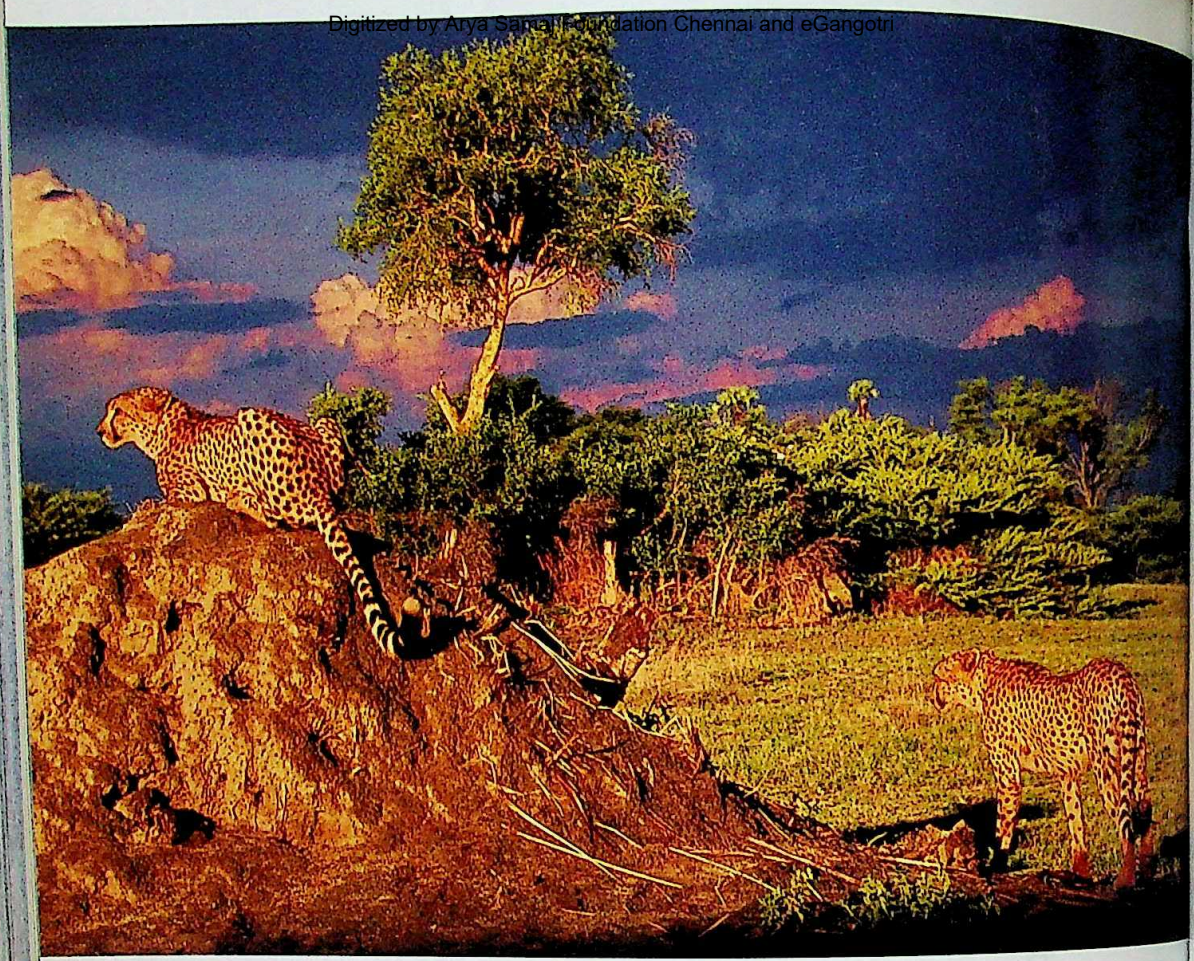

haunches while Talisker adjusted her bite for the slow strangulation. The wildebeest's hoofs flailed in the air. The cubs wandered off, looking vacantly away from the kill. "Waiting for mum to prepare the food," Durant said.

We waited too, and I reflected that I had come to a strange pass in my career as a natural history writer. The predation was familiar enough, but I wasn't accustomed to such pretty killers. My inclination has always been to write about the less popular animals on Earth, so taking on cheetahs was a bit like a crime reporter being asked to profile a *Sports Illustrated* bathing suit model. I was appalled, and also ineluctably attracted.

A cheetah ambling across a field is among the most beautiful animals on Earth, long legged and slim, shoulders rolling, lithe as a fashion model on the runway. Then the cheetah breaks into its 60-mile-an-hour sprint, and it's as if Naomi Campbell has transformed instantly into Jackie Joyner-Kersee: The spine flexes up and down with each huge stride, the wide nostrils flare, the head weaves back and forth to fix the cheetah's big copper-colored eyes on its prey, and the tail stretches out to counterbalance the cheetah's weight on sharp turns. It becomes a blur of golden fur and dark spots, all speed and deadly finesse.

So why appalled? It had to do with human attitudes. Partly it was my own misguided notion that a creature as beautiful as the cheetah, the poster child of tire companies and tourist hotels, should need no help from me. And partly it was because cheetahs are cats, and they elicit the sort of cat-lover sentimentality that makes me cringe. One day a conservationist who ought to have known better pointed out the characteristic black lines running down from the inside corners of the cheetah's eyes and described the cheetah to me as "the cat that cries."

Something about cheetahs makes us patronize them. Maybe it's because they're the only big cats that do not normally attack humans or because they're the only ones that cannot roar.

RICHARD CONNIFF's most recent book, *Every Creeping Thing: True Tales of Faintly Repulsive Wildlife*, was published last year by Henry Holt.

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(They growl and hiss. But they also whimper at one another like birds.) Humans have tamed cheetahs as pets and kept them as hunting animals for at least 3,700 years, and our ability to dominate them has given us the idea that cheetahs are only half wild.

In fact, about 1,300 cheetahs now live in captivity and perhaps 12,000 in the wild. In my lifetime they have vanished from Asia, except for a few in Iran and Pakistan, and dwindled to a rumor in North Africa. They are disappearing below the Sahara too as the growing human population encroaches on old cheetah habitat. Parks provide some refuge, but most parks are overloaded with lions, which kill cheetah babies and steal cheetah kills.

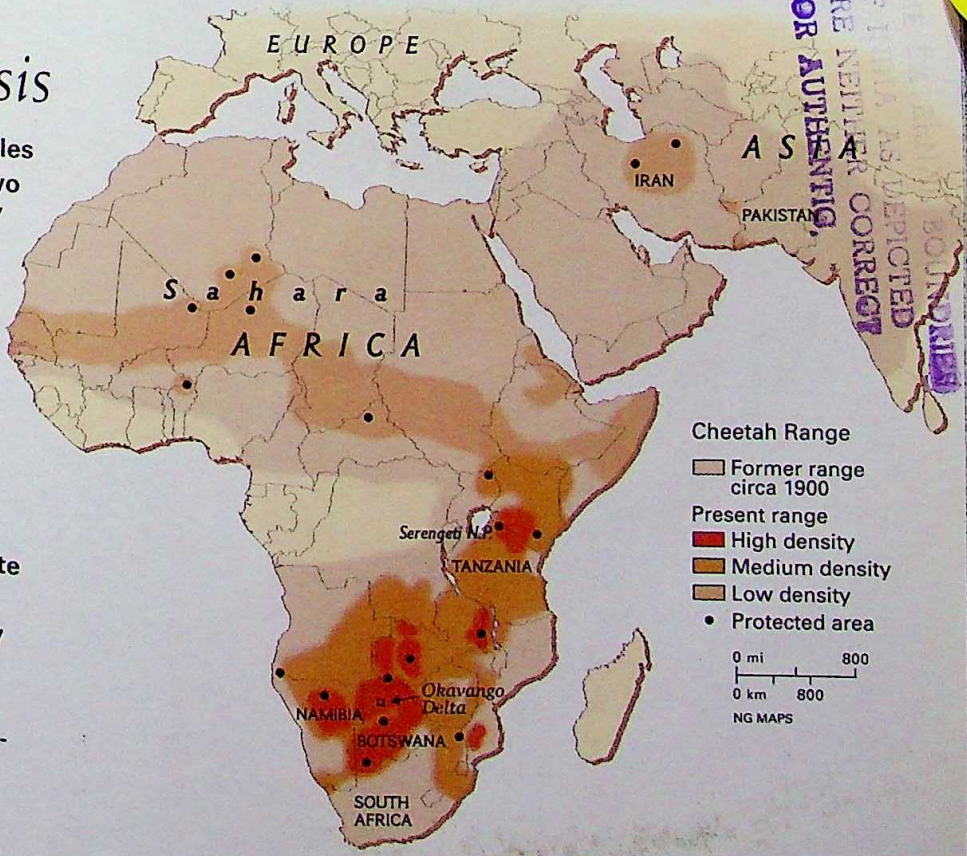
THE SERENGETI in northern Tanzania is one place where it's still possible to see how cheetahs live in the wild, untainted by sentiment. Over the past 25 years biologists at the Serengeti Cheetah Research Project have come to know more than 400 individual cheetahs, using their distinctive spot patterns as identifiers. They have also constructed genealogies, stretching back in Talisker's case to her great-grandmother. Durant, who now heads the project, is a tall, handsome Englishwoman from the Zoological Society of London, 36 years old, strong-chinned and soft-spoken.

As we waited at the wildebeest carcass, Durant recalled meeting Talisker as a cub and later as "a hopeless adolescent." The cheetah's deadly finesse does not come easy, Durant said. Cubs spend about 18 months with their mothers learning how to survive, and it may take them another year or two to become good hunters. They often start out chasing wildly inappropriate prey, including buffalo. Talisker, said Durant, would hunt right in front of a hyena and then be surprised when it took away her kill. But she also learned from her mistakes. "Talisker's a pretty switched-on cheetah. She's quite vigilant, and she moves away if she sees a lion or a hyena. She hides her kill where she can. She's a good hunter." She's also a successful mother, having already reared two litters to independence. Most females, said Durant, rear fewer than two *individual* cubs to independence in an average lifetime of seven years.

Talisker was now sitting off to one side, leaving her cubs to sort out the wildebeest. One of them touched it gingerly with a forepaw. Another stared down at it, then at his mother, then back at the carcass, like a kid confronting

Cats in Crisis

A termite mound doubles as a watchtower for two brothers—a "coalition"—that scout for predators and prey in their territory. Cheetahs once thrived in Africa and Asia. But lion predation haunts their young, and farms and ranches have reduced their habitat, leading to indiscriminate killing by ranchers protecting livestock. Today some 12,000 cheetahs live in 30 countries, helped by conservationists—and a growing number of ranchers.



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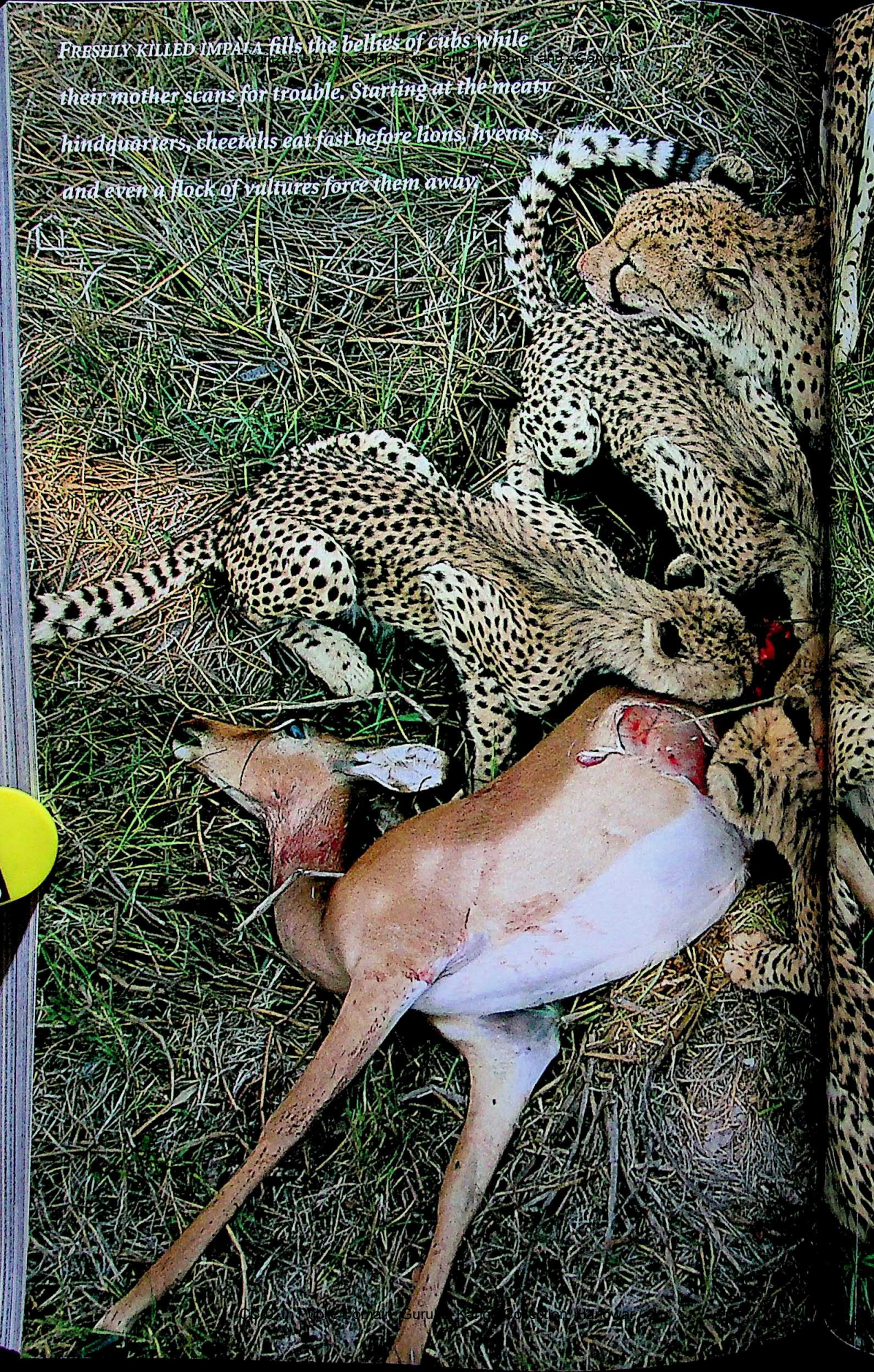

Freshly killed impala fills the bellies of cubs while their mother scans for trouble. Starting at the meaty hindquarters, cheetahs eat fast before lions, hyenas, and even a flock of vultures force them away.

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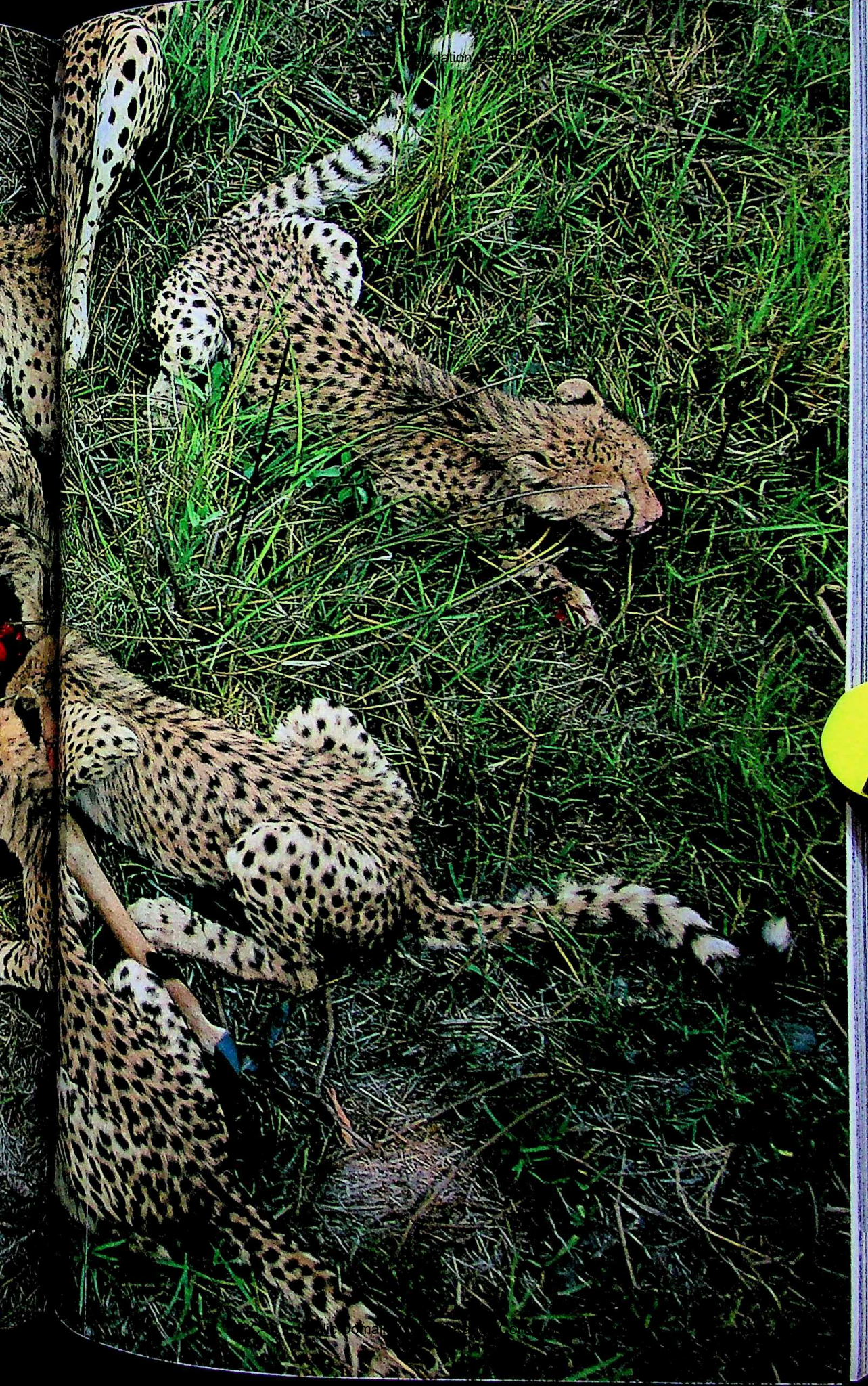

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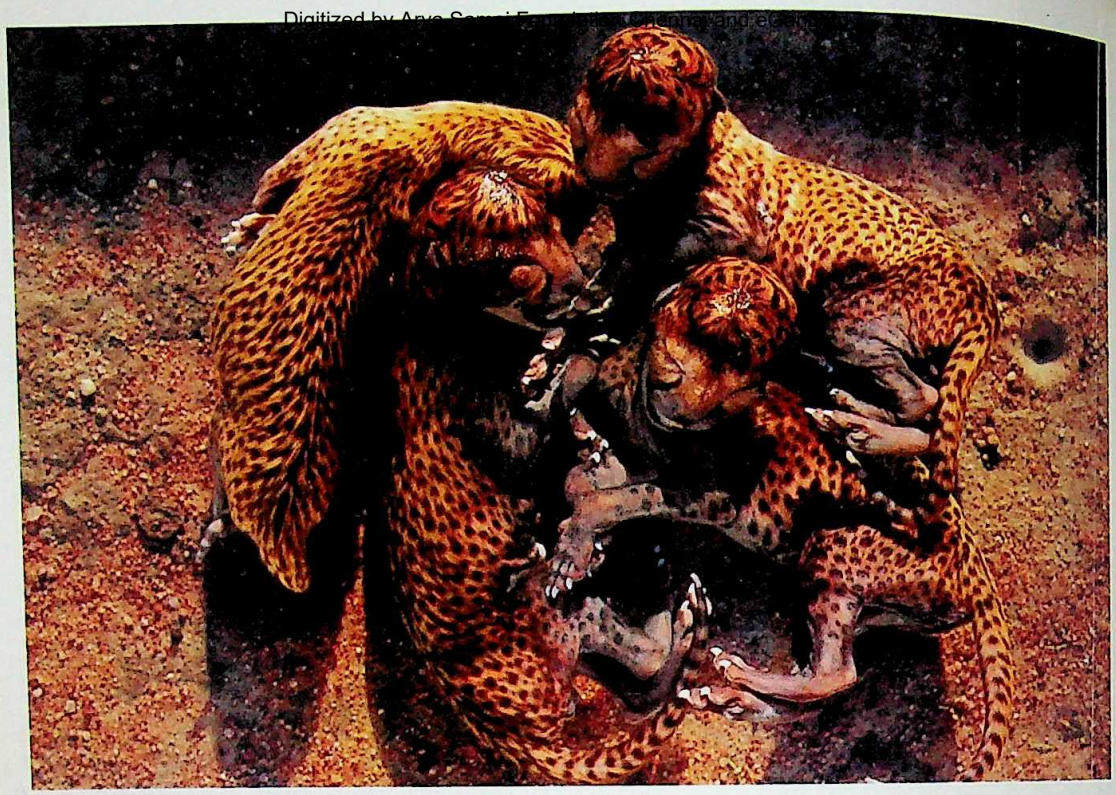

his first lobster dinner and hoping for help. "Wildebeest have thick skin, compared with gazelles," Durant said. Cheetahs also have small, delicate mouths. Their big eyes are set forward, the better to focus on prey, and the foreshortened face leaves little room for the mouth. One cub practiced a clumsy throat bite on the carcass. Another gnawed at the thin, webbed flesh where the hind leg joins the belly.

The heat shimmered sideways across the open plain. The clouds became cottony and less ominous. When the cubs came up from the kill now, their mouths were blood-red. Talisker joined them, and the wildebeest's midsection seethed with golden fur and spots and black ears and sharp elbows. Sometimes two cheetahs fed opposite each other, with the tops of their heads pressed together like bookends. Sometimes they ate cheek to cheek and growled at one another over tidbits. After an hour the cubs had clownish round bellies, and their faces looked like Kabuki warriors', covered with blood all the way back to the ears. They took turns eating now.

"She's about a 12," Durant said, eyeing Talisker's belly. Still room for topping off. "It might hurt, but she'll do it." Cheetahs normally get a kill only every one to three days and sometimes lose their dinner to lions and hyenas. So gorging makes sense. Three hours later the cheetahs were still occasionally picking at their food, but mostly lying around, their bellies now spotted white hillocks rising from their midsections. Vultures had begun to edge closer, like waiters who want a banquet to be over so they can clean up and go home.

ONE DAY Durant and I were talking about why cheetahs are so scarce, and I asked her, "Do you ever get to hate lions?" "Surely everyone does?" she joked. "They are the thugs and bullies of the Serengeti. Of everywhere, really."

Cheetahs are not sturdy enough to defend themselves from either lions or hyenas, so they have become expert at being elsewhere employed. If their rivals hunt mainly by night, cheetahs hunt by day. If their rivals favor thick herds of wildebeest, cheetahs concentrate on gazelles and hunt where the prey is less dense and there are fewer eyes to notice them slinking through the grass. The cheetah's famously swift chase lasts, on average, only ten seconds, and brevity is a good thing. It means the flurry of a chase is less likely to attract attention. After bringing down her prey, a cheetah will typically lie still for several minutes to recover her breath

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and also to check that no one is watching.

For a cheetah the real danger is not losing a kill but losing her cubs. Ninety-five percent of cheetah cubs die before reaching independence. Hyenas kill them out of hunger, lions apparently out of bad habit. Durant theorizes that killing cheetah cubs is simply an extension of the male lion's urge to kill the cubs of any unknown lioness so he can get her pregnant with his own cubs. Lionesses kill cheetah young too, to protect their territory. Female cheetahs deal with the threat by constantly moving, preferably before their rivals even know they're around. They coexist as a phantom species, slipping into temporary vacancies between prides of lions and packs of hyenas. Over the course of a year a female in the Serengeti will typically wander an area of some 320 square miles, larger than New York City. Several females may overlap in their wanderings, but, even so, cheetahs tend to be thin on the ground. Durant believes that there are no more than 250 cheetahs spread out across the Serengeti ecosystem, versus 2,800 lions and 9,000 spotted hyenas. The entire cheetah population of sub-Saharan Africa may have been small even in the best of times.

If females wander the whole city, males usually stick to a few choice saloons on the Upper East Side. Because they have no cubs to worry about, they can maintain and defend small territories, averaging about 20 square miles. Two or three males, usually brothers, may hold a territory jointly. One day Durant and I watched such a coalition, two males both pushing 12 on the belly-fullness scale, prowl through the bush, stopping now and then to gaze at antelopes and wildebeests. "I often think they watch prey the way we watch television," said Durant, "because it's comforting and mindless."

The cheetahs headed for the tallest tree in the neighborhood, an umbrella acacia, and squirted urine on the trunk at roughly cheetah nose height—a message that, according to one researcher, tells rival males, "If I catch

Days before birth, four cheetah fetuses (opposite) died after a Namibian farmer shot their mother. In Namibia 90 percent of wild cheetahs roam private farmland, but conservationists like Laurie Marker, tagging a captured cheetah with farmer Ralf Ritter, hope ranchers will call them for help rather than kill these predators. "I want my children to grow up where cheetahs run free," Ritter says.

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TRAPPED FOR EIGHT DAYS, a cheetah caught near injured calves waits to be picked up by conservationists. During its captivity it was fed and watered, then treated for minor injuries before being tagged and released.

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DAVE HAMMAN

Tag-team Pursuit of Prey

Capable of speeds of up to 65 miles an hour, a male cheetah catches up with a lechwe in the wetlands of Botswana and attempts to swat it down with his paw (top). Desperate and struggling, the animal manages to reach a water hole, but there the cheetah's brother joins in to wrestle the lechwe down for good. Lacking the strength of larger cats, cheetahs are masters of maneuvers. In this case, they hold the winded antelope underwater until it drowns—a form of cheetah kill rarely, if ever, before recorded.

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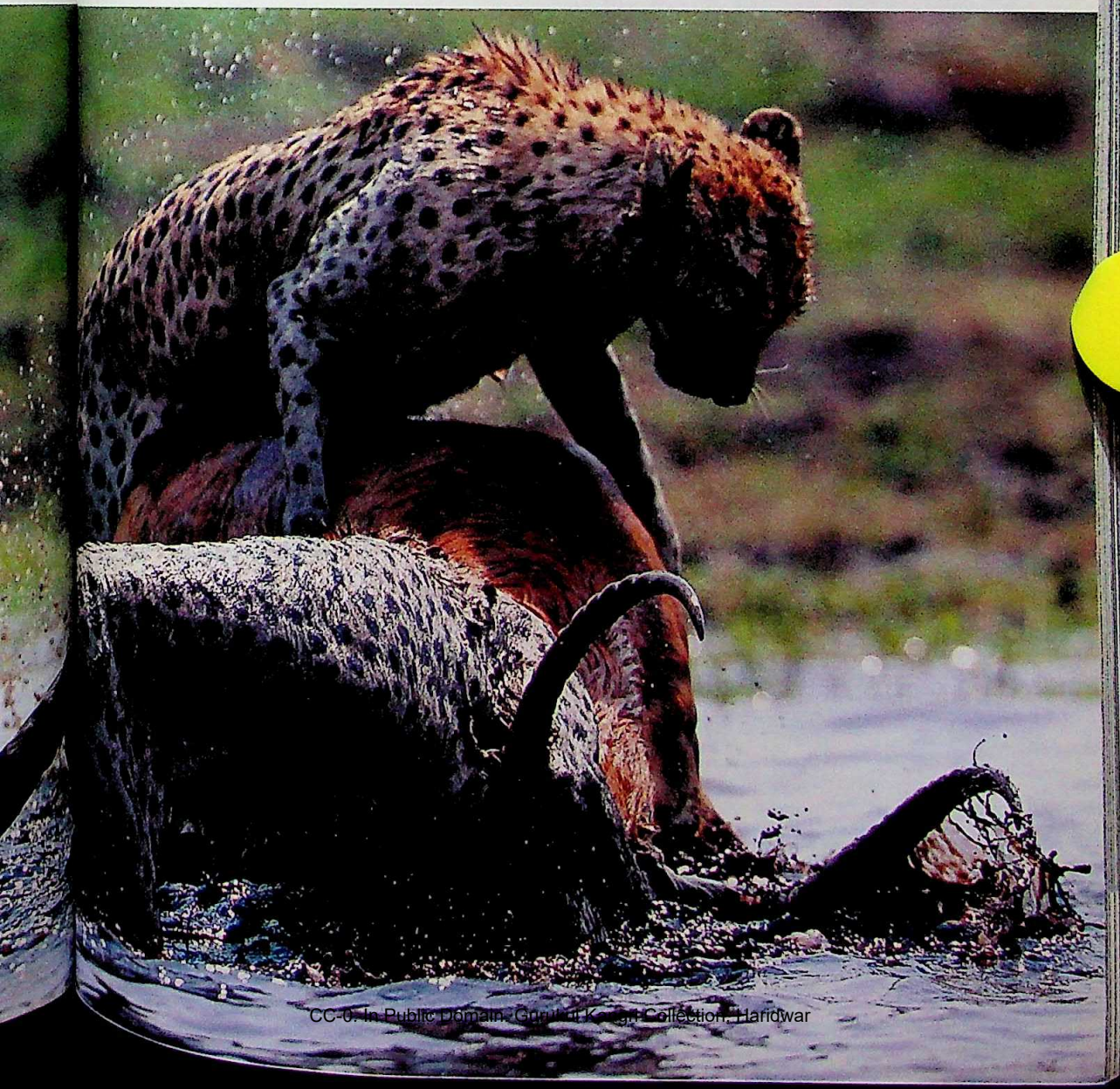
you in my territory, I will kill you." It's also a way to get the attention of passing females.

Paternity is one of the great unknowns of cheetah biology, not just for researchers but for the cheetahs themselves. A female's home range may contain three or four male territories, and she may mate with any of the resident males, as well as with floater males that pass through. Durant has seen cheetahs mating just once. It involved a coalition of three males named Daniel, Day, and Lewis, after the actor, and a female named Florence. All of them disappeared into the bush. After a few seconds Durant saw what she called "stacked cheetahs," Daniel, Day, and Lewis mounted one atop the other, with Florence "looking rather squashed" on the bottom. But confusion can be a good thing. Unlike lions, male cheetahs have never been known to kill cubs, perhaps because they have no way of knowing whether the cubs are their own offspring.

The question of who fathers the cubs is of special interest because cheetahs are a genetic mystery. In the 1980s researchers discovered that all cheetahs are genetically similar—so much so that skin grafts from one cheetah to another produce no immune reaction. The finding caused geneticists to rethink the cheetah's evolutionary history: Roughly 20,000 years ago cheetahs ranged around the world. At different times there were two species in North America. But cheetah populations apparently suffered a drastic decline about 10,000 years ago, and all cheetahs now living appear to be descended from a relative handful of survivors. No one really knows what this signifies for the future of the species. Some biologists suggest that, having survived the population bottleneck and recovered, cheetahs in the wild suffer no ill effects from their genetic homogeneity.

DAVE HAMMAN



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Others believe that they may be unusually vulnerable to any small change in their environment, particularly disease. Either way, the cheetah is a conundrum: The fastest animal on land, an apparent model of evolutionary fitness, is also as inbred as the average lab mouse.

"The more information you get, the more fascinating an animal becomes," Durant said one day. "It doesn't matter if it shows that an animal is more peaceful than we thought, as gorillas seem to be, or more aggressive, as with chimps. It's the information itself. Anything that makes people value an animal for what it is, rather than for our fantasy of what it is, the better it is for the animal." I had a small problem figuring out how to value the Lion King as a cub killer and a kleptoparasite. But cheetahs were beginning to grow on me.

I WENT to Namibia, on the southwestern coast of Africa, where people were advocating a different, distinctly utilitarian view of cheetahs. The world's largest wild cheetah population lives here and thrives largely because landowners have exterminated lions from the huge private ranches that dominate the countryside. Unfortunately the ranchers mostly regard cheetahs as vermin too; they're just not so easy to get rid of. Namibia has about 3,000 cheetahs, down from perhaps 6,000 in the 1980s, and many ranchers argue that the best hope for saving the cheetahs is to let wealthy foreigners trophy-hunt a small percentage of them each year. It's a measure of how tangled and difficult the question of cheetah conservation has become that even some environmentalists say the ranchers are right.

Traveling Namibia's excellent two-lane blacktop highways, I frequently had the strange sensation that I'd just woken up in Wyoming. The highway rolled for hours through a flat landscape of parched grass and tangled gray scrub. Red rock reared up in knobbled sandstone ridges and strange, fanciful promontories, here a pyramid, there a planetarium. The descendants of European colonizers, mostly Germans and Afrikaners, make up only about 5 percent of the population in Namibia, which won its independence from South Africa in 1990, but they still dominate the rural landscape. Their lovingly tended desert towns have rows of palm trees planted in the medians and little churches lifted intact out of the Bavarian countryside. Their long fences divide the desert into vast, arid ranches where antelope roam, along with cattle and cheetahs. Almost all the ranchers I visited were dyspeptic on the subject of predators, the way American ranchers talk about wolves or grizzlies.

At his 19,000-acre ranch south of the Waterberg Plateau, Tinus van Rensburg came out to greet me and immediately held up his left hand to ask if I'd brought him a new finger to replace one bitten off a few months before by a cheetah. He was wearing a surplus German Army overcoat, and he had scraggly dark hair, a thick beard, a gap-toothed grin. Inside we sat by the fire with an old cheetah-skin rug beneath our feet and a caracal hide covering the table. Van Rensburg began to recite the basic problem with cheetahs: In short, they eat the same meat we do and often get there first.

As a cattle rancher, van Rensburg said, he used to lose 15 calves a year to predators. The problem only got worse when he abandoned cattle and converted his ranch to trophy hunting. He stocked his ranch with black-faced impalas, springbok, and blesbok, and the cheetahs ate almost all of them—$24,000 (U.S.) worth in the past three years.

"Oh!" he said, "my heart pumps blood. One day you feel that the cheetah also has a right to stay here. But you get angry, and the moment you see a cheetah, you start shooting. I think you would feel the same." I asked him how many cheetahs he typically took off his land. "Oh, that's a lot," he said. "Last year I think I catch and shoot 17."

The accident that cost van Rensburg an index finger happened when he released his grip on the neck of a cheetah he had trapped and it spun around, catching his finger in its side teeth and holding on. "I could do nothing. I must sit and wait till he is finished," van Rensburg said. He killed the cheetah. But he meant to suggest that his antipathy toward the

Too closely related for comfort, cheetahs as a species are genetically almost identical. Some 10,000 years ago cheetah populations were decimated. A smattering of survivors gave rise to those living today—animals whose homogeneity may make them more vulnerable to disease.

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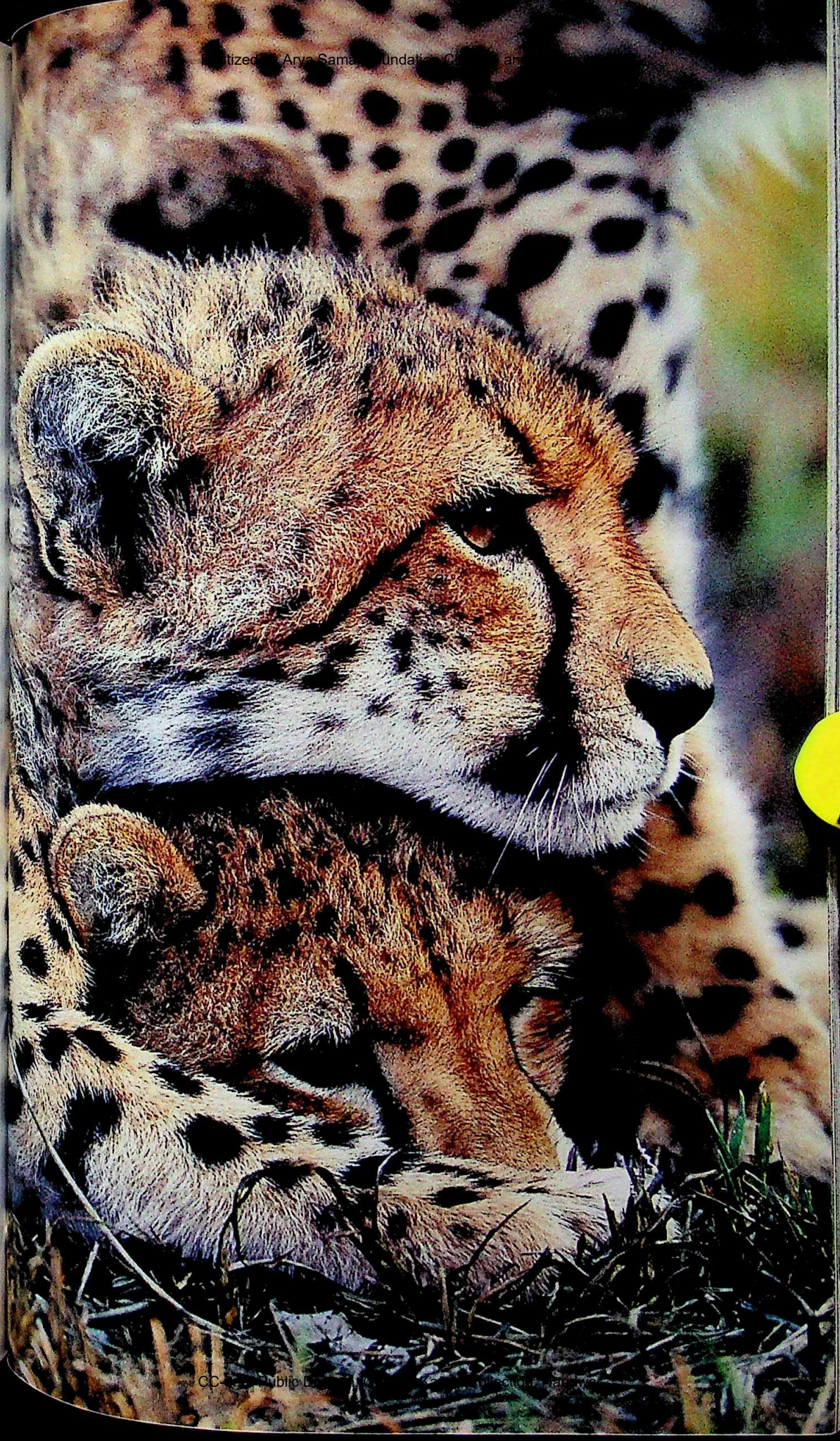

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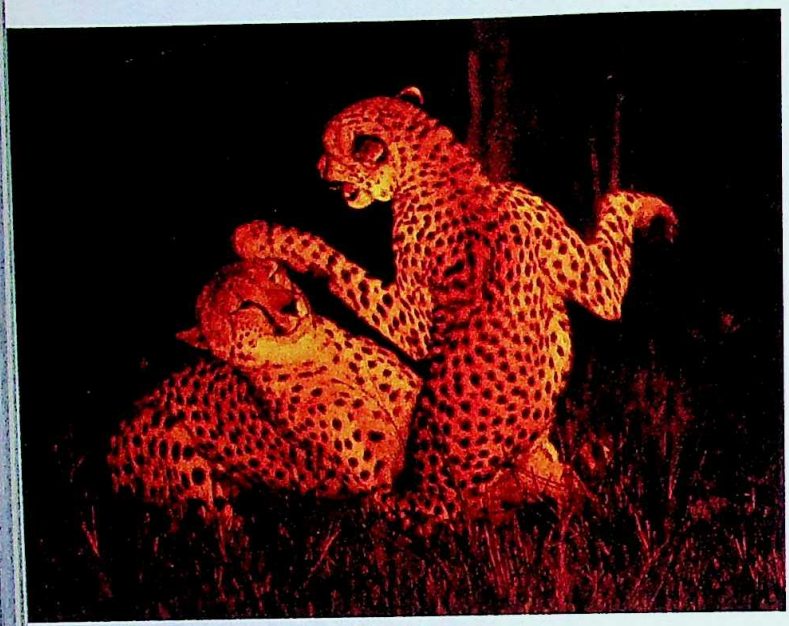
Rough Rebuff of a Night Attack



When a female and her adolescent cubs wander into their territory, two brothers—dubbed the Steroid Boys—move in, aggressively challenging the mother (below). Fearing for her cubs' safety, she bats one of the males away (left) and shoves the other (right). Female cheetahs live alone with their young and mate just before the cubs reach independence at between 18 and 22 months. This cheetah paid a painful price for successfully fending off the brothers: Cuts on her leg sent her limping into the night. But she is lucky to be alive.

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species was merely practical, not psychological. Of the finger, not Ahab after his white whale, he said, "I think that was my own stupid thing to do. But I blame the cheetah for the small game because I've lost a lot of money."

The ranchers I talked with readily volunteered that their cheetah problems were at least partly of their own making. "There's far more cheetahs today than there were a hundred years ago," one rancher said. Back then, when the water vanished during the dry season, the grazing herds went elsewhere, along with their predators. But the ranchers put cattle watering holes everywhere, inadvertently making it possible for game and cheetahs alike to remain in the desert year-round. The ranchers also wiped out hyenas and lions, leaving cheetahs and leopards as the top predators. In the 1980s Namibia's cheetahs were thriving on a growing population of antelope, particularly kudu.

Then the kudu went bust because of drought and disease, and the cheetahs increasingly turned to livestock. Ranchers were allowed to kill cheetahs without limitation, and the government estimates that they took as many as 600 a year. "They were required to report kills," a professional hunter named Volker Grellmann recalled. "But most didn't. They threw 'em into an aardvark hole and covered 'em up." The killing has since slowed to about 180 cheetahs a year, according to a Namibian wildlife official, though he added that the number may still be "way underreported."

None of this sounded to me like an argument for trophy hunting. But that was one of the main strategies being discussed for cheetah conservation, as a way to make cheetahs valuable to the ranchers. The Namibian government and several hunters have applied to the U.S. Department of the Interior for permission to import up to 50 trophy cheetahs a year. U.S. permission matters because American hunters are willing to pay big trophy fees for cheetahs.

"The fate of the cheetahs is in the hands of the ranchers," said Grellmann, a Hemingway look-alike with a broad face, a white beard, and blue eyes peering over black reading glasses. "You have to appeal to their goodwill and offer them something in return to compensate them for their losses." If ranchers could invite hunters onto their property, he said, and charge them a thousand-dollar trophy fee to kill a cheetah, with 15 percent going to a conservation fund and the rest split between the landowner and hunting guide (often the same person), then cheetahs might become an asset instead of a nuisance. The parsimonious mind-set of ranchers strongly militates against flinging thousand-dollar animals into aardvark holes. Trophy hunting has worked with other species. The grazing herds of wildlife are once again abundant, Grellmann said, because ranchers protect them as a cash crop. Cattle now sell for about $300. But a kudu can be worth $900 just for its head, and as one incredulous old rancher put it, "You get to keep the meat." The cheetah, he said, must also "become part of the utilization process."

ONE EVENING I went out to watch a tame cheetah getting his exercise in a huge hayfield, with the long red bluff of the Waterberg Plateau lit up by the setting sun in the background. The exercise lure, a bright rag on a ground-level wire-and-pulley system, took off, and the cheetah lit out in pursuit till he pinned it down with his forepaws. Then he lay panting helplessly on the ground. He allowed me to handle the tire-tread pads on his feet and the cleatlike, semi-retractile claws. I felt the curved dewclaw on his foreleg with which cheetahs snag and trip their prey when they swat out at the end of the chase.

The cheetah's owner, an American conservationist named Laurie Marker, was explaining to a group of Namibian agriculture students that cheetahs are relatively weak killers. They can't pierce a victim's neck with their teeth, as leopards do. The adaptations that help make them such fast, efficient hunters also make them vulnerable at the moment of success to more powerful cats, like the lion. The students regarded the animal warily. Marker treated the cheetah like a pet, but to them it was still a predator, the enemy.

Wild at heart but raised in captivity, three-year-old Chewbaaka was orphaned in infancy. Rescued by Laurie Marker, founder of the Cheetah Conservation Fund in Namibia, he regularly chases a mechanical lure for exercise. Captive cheetahs sometimes suffer from obesity and often develop stomach and kidney problems.

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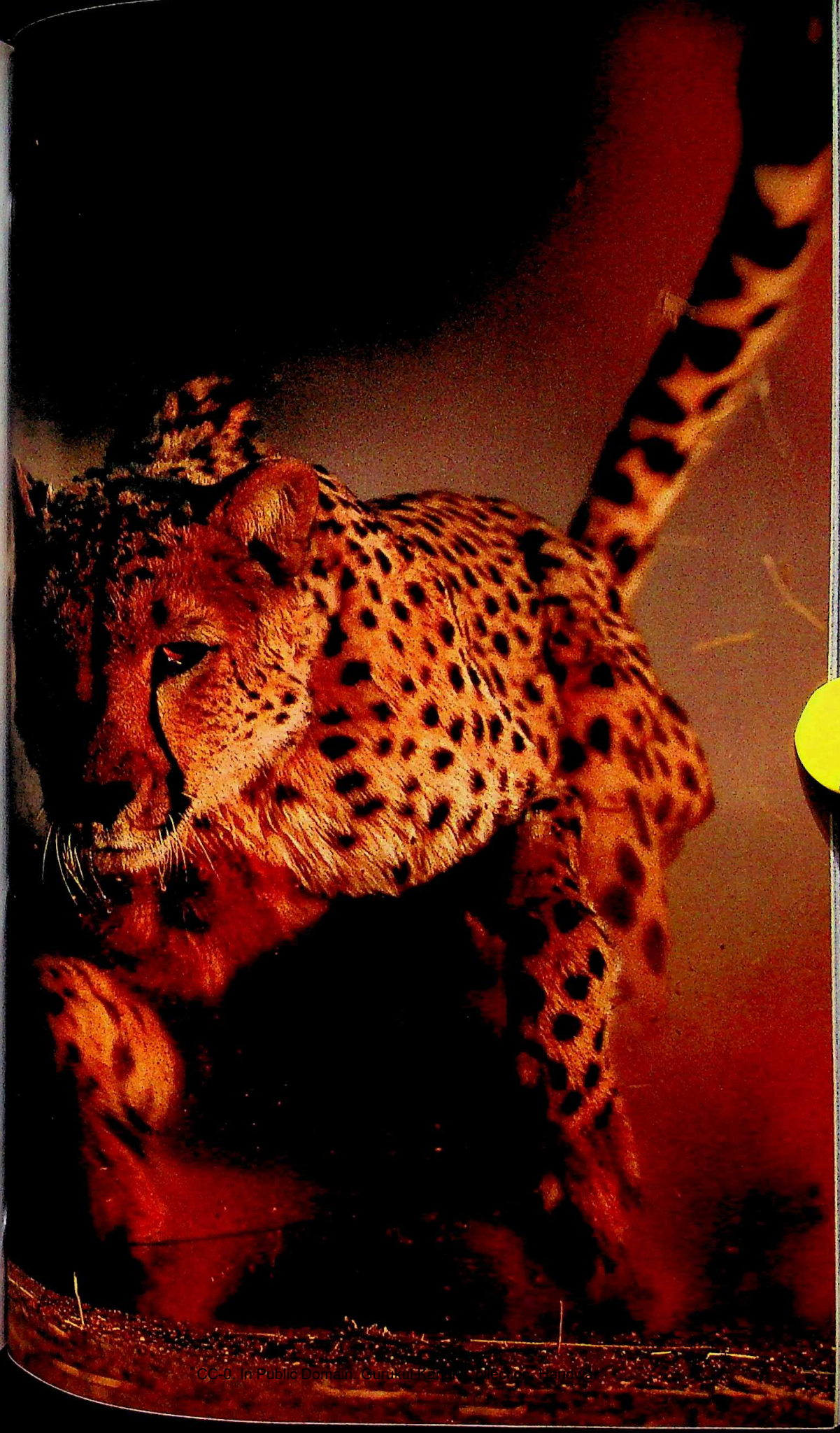

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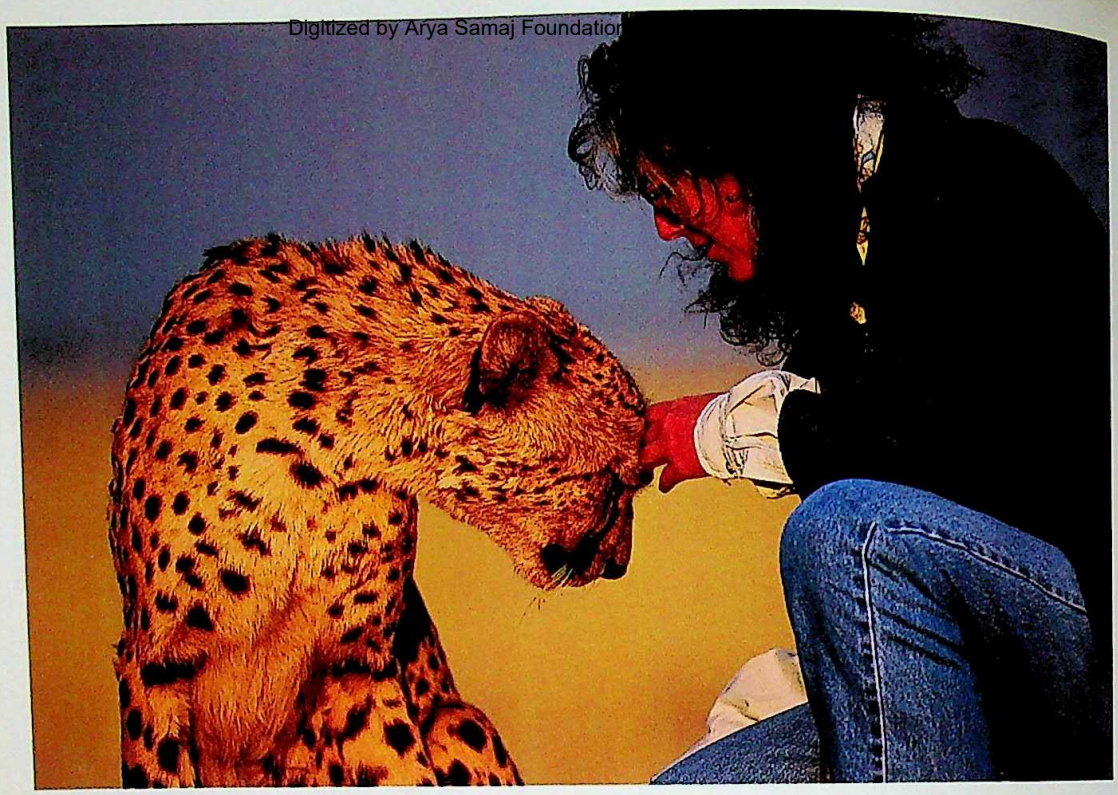

Back in the 1980s when Laurie Marker first heard how many cheetahs were being killed each year in Namibia, her impulse was to save the animals by catching them and putting them in parks or zoos. She'd made a career as a specialist in captive breeding of cheetahs in the United States. But Marker began to think that zoos could be part of the problem, as well as the solution. So in 1991 she moved to Namibia and formed the Cheetah Conservation Fund (CCF) with the aim of saving cheetahs in the wild.

Marker, a 44-year-old with big, tinted eyeglasses and dark ringleted hair, had little experience with animals in the wild. She is a lover of dogs, goats, and house cats, all of which she addresses affectionately: "Aren't you the most beautiful girl? Yes, you are." She talks almost the same way to visitors to her cheetah education center on a farm outside the town of Otjiwarongo. Moreover, she does not speak German or Afrikaans, the languages of the ranchers. Not surprisingly, the ranchers gave her the sort of warm welcome customarily reserved for Americans arriving in foreign countries to tell the locals how to behave. "In the beginning," Marker said, "I thought we were going to get shot."

But her arrival in Namibia, and the cheetah survey she began to conduct among the ranchers there, sent a message: The outside world, which otherwise scarcely knew the place existed, actually cared about Namibia's cheetahs. At their ranch on the other side of Otjiwarongo, Wayne and Lise Hanssen soon formed a homegrown cheetah and leopard conservation group called AfriCat. Though the egos on both sides frequently clash, AfriCat and CCF take the same approach of gentle persuasion with hostile ranchers. "We never say 'Don't kill cats,'" Marker said, "because the door just closes."

Wayne Hanssen, a 35-year-old with a red mustache, a bush hat, and a skinning knife at his belt, won his first reluctant convert in his father, a traditional rancher who had been losing more than 20 calves a year to predators and shooting any cat he came across. "He said he'd stop shooting when we got the loss down to five calves a year," Hanssen recalled, sitting on the hood of his Land Rover. To reduce predator losses, the Hanssens tried using guard animals, building better fences, and penning up the calves at night. "Now, after ten years, he can't explain why he shot those cats. We proved by intensive farming methods that we could minimize the losses."

Most ranchers, Hanssen quickly added, aren't willing to make the effort. But the campaign of gentle persuasion appears to have

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produced at least one significant change: soothingly, "I've got your mama at home."

Having trapped a cheetah, many ranchers are no longer so eager to kill it. Instead, they call AfriCat or CCF to collect the animal. AfriCat was originally paying up to $250 for cheetahs, but both groups now oppose payment.

Hanssen aimed a long aluminum blowpipe at the caged animal and quickly fired a tranquilizer into his flanks. Then the children carried the unconscious 70-pound cub to a truck for a medical examination and the trip back to the Hanssens' ranch, where he would rejoin his mother. By the end of the week the whole cheetah family was reunited in captivity, and after a six-week quarantine Hanssen released them into a game reserve as part of a large-carnivore reintroduction program.

One problem with this warm scenario is that trapping can become a feel-good way to eliminate cheetahs in the wild. In South Africa most of the cheetahs have already vanished from private lands into zoos and game parks, which can be a reproductive dead end because of the cheetah's complex mating behavior and the potential for inadvertent inbreeding. Most U.S. and European zoos now swap animals and cooperate in other ways to improve reproduction by captive cheetahs. But South African zoos and

ONE DAY I went with Lise Hanssen to retrieve a trapped cheetah. Three generations of the von Oppen family and their farmworkers drove out to the trap in a festive caravan. Jennifer Lee von Oppen, a nine-year-old, was planning to do a school report about cheetahs, and the last thing anybody wanted was to see the cheetah dead or to break up a cheetah family. Hanssen had picked up one cheetah from the von Oppens a few days earlier, and now two more cheetahs waited outside the trap. They fled as we approached, leaving their trapped brother to pace nervously in the cage. He spat when Hanssen came near, and she spoke to him

"I'm the only mother he's known," says Marker, with Chewbaaka (left). Without the skills passed on by their real mothers, captive cubs will not survive if released into the wild. Many are sold to zoos for up to $6,000 (U.S.). Still just a prince (below), a rare king cheetah (worth $25,000) is the result of a recessive gene. Except for darker elongated spots, kings are genetically identical to other cheetahs.

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FRAMED BENEATH A FULL MOON, a cheetah prowls for impala and small game. Though these cats typically hunt during the day, they're clearly opportunists. "Cheetahs are very creative," says one researcher. "Nothing they do surprises me."

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game parks have been slow to get involved, according to Laurie Marker, who manages the International Cheetah Studbook. Many of them treat captive-born cheetah cubs, which sell for up to $6,000 apiece, as a lucrative business. "When they have animals that don't reproduce, they call up farmers in Namibia and say, 'Please, will you catch some cats?'" Marker said. "Most want females, and for every female caught, the farmer typically catches 10 or 15 males."

"The perception is that zoos are saving the cheetahs because they're taking problem animals that would be shot," said Bonnie Schumann, a South African on the CCF staff. "But they aren't just taking problem animals. Sometimes they create problems by paying farmers to open their cages and catch cheetahs."

Despite the apparent success of captive-breeding programs at some zoos, no one is attempting to reintroduce captive cheetahs to the wild. There are relatively few wild places left in Africa or Asia big enough to accommodate cheetahs or willing to accept them. Thus both CCF and AfriCat emphasize protecting the existing population in Namibia and persuading ranchers to tolerate cheetahs in the wild. Despite their cat-lover orientation, both groups have come to support trophy hunting as one practical way to accomplish this. Hunting, said Marker, "won't make anybody rich, but it's an aspect of management."

I went to visit a young hunting guide named Jochen Hein at his game ranch near Okahandja, where a pet cheetah named Maggie patrolled outside the kitchen door. As we toured his ranch, Hein told me about a trophy cheetah one of his clients had recently shot on a neighboring farm. The neighbor, he said, used to kill cheetahs as pests. Then Hein paid him the cheetah trophy fee, and the farmer's jubilant wife confessed that it was their first income of any kind in six months.

"When we killed the cheetah," Hein recalled, "I said, 'Look, you're getting this money, keep those cheetahs for me. Please forget these damned traps.' A lot of these farmers, they need to see it for themselves. They need a professional hunter who will shoot a cheetah on their property and give them some money."

Hein helped write Namibia's new cheetah hunting compact, which sets the terms for an ethical hunt. More than 250 professional hunters have signed the compact, and hunters bringing trophies from compact signatories would be eligible for import into the United States. But biologist Sarah Durant doubted that the compact would protect cheetahs. It's too easy, she said, for cheetahs to wander from ranches that observe the compact to neighboring ranches that continue to trap and shoot.

Some hunters also objected to the new rules. Volker Grellmann figured that a visiting hunter who spent 14 days in the field following the new rules would have only a 20 percent chance of even seeing a cheetah, much less getting off a shot. No landowner was likely to get more than one or two cheetah trophy fees a year, and the fees would never equal what the rancher lost from having the cheetah there in the first place. I repeated these criticisms to Hein, who replied that hunters would spend those 14 days taking kudu and other common game (and paying trophy fees on them), drawn on by the elusive prospect of a cheetah.

I said good-bye and headed from Hein's ranch to the nearest gas station, at an empty corner in the middle of the desert, where I happened to find the very farmer to whom Hein had recently paid the cheetah trophy fee. He was a silver-haired, dark-eyed man of about 50 in a leather jacket. When I asked him if cattle ranching paid a decent living these days, he laughed softly. He told me the usual story about losing 20 calves a year to cheetahs. I asked him how he felt about them now that he'd earned his first cheetah trophy fee.

"When I see them," he said, "I shoot them."

Maybe it was just bluster, a rancher saying what his father and grandfather always said. Or maybe old animosities do not vanish in one transaction, or even in one generation. "I can't honestly say we've ever turned around a farmer so that he never shoots a cheetah again," Wayne Hanssen had told me. Then he added, "We've got a lot of farmers thinking twice."

NEAR THE END of my visit in Namibia I went out one morning in search of radio-collared cheetahs with Laurie Marker. We took off from the dirt road outside the CCF farm, with radio-tracking antennas clamped onto both wing struts of a Cessna 206. The pilot's technique for pinpointing an animal's location was to fly figure eights in the vicinity of the radio-collar signal, banking so

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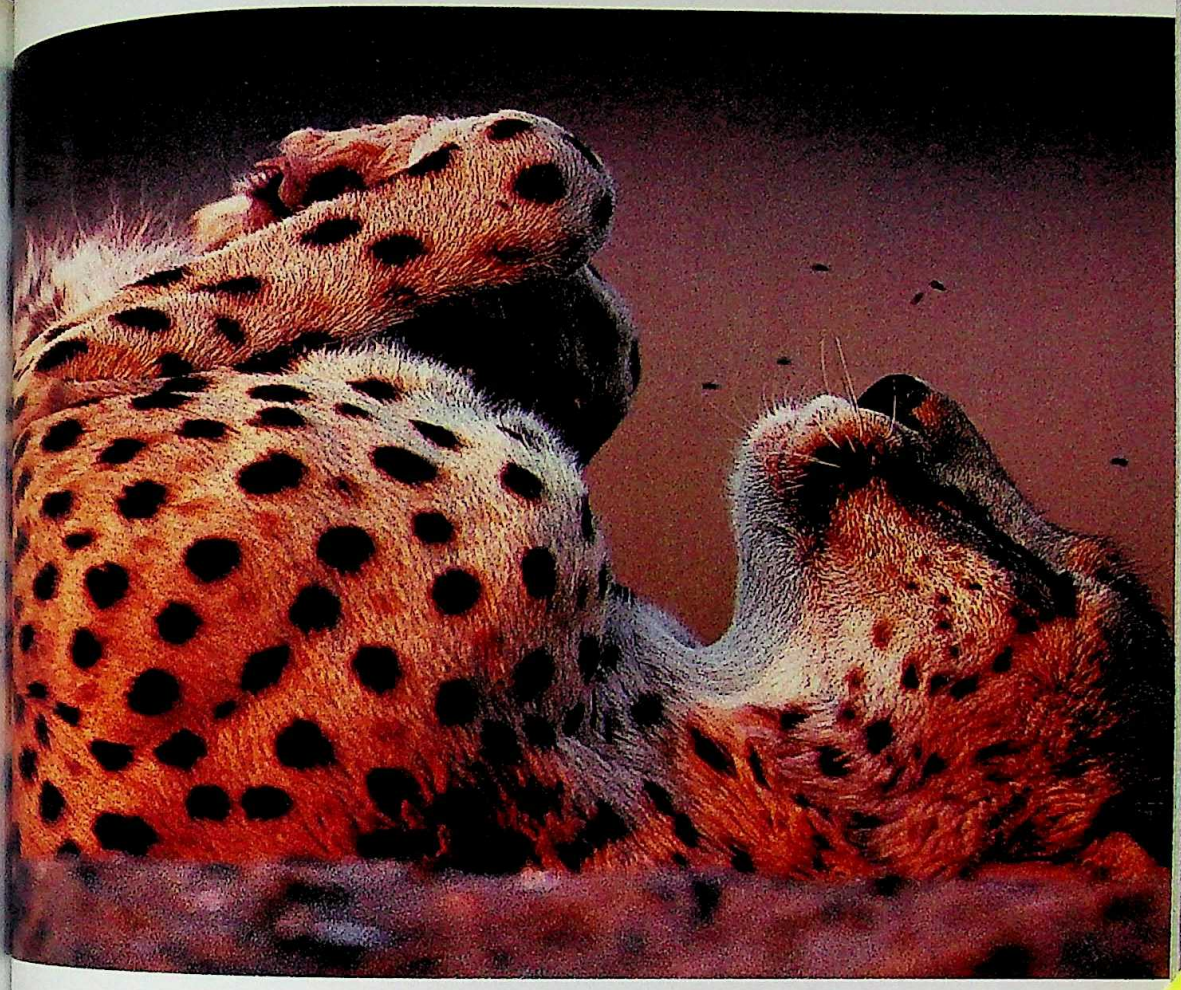

Not even a swarm of flies disturbs a cheetah's after-dinner catnap. Most delicate of the big cats, cheetahs choose to flee rather than fight when confronted with danger. "People are their biggest problem," says Laurie Marker. "Whether cheetahs thrive in the wild or are lost in our lifetime is ultimately up to us."

steep and so low that the entire port window was filled with the thorny earth skidding past just beyond the wingtip and the starboard window was all empty blue sky. Then the plane seesawed over, and we did it on the other side. I got the feeling that the hairy love grass and *wag-'n-bietjie*, or wait-a-bit bush, was going to reach out and haul the plane into the undergrowth.

We leveled off just above the ground and cruised past two cheetahs seated alongside a fence. One of them looked at this winged apparition, and his eyes burned with a color like the embers of a banked fire. Then he turned away with magisterial feline indifference. In truth, it was almost contempt.

I contemplated the trade-off: Those eyes replaced with glassy baubles. That head mounted on some trophy room wall, to be admired by cigar-waving partygoers and to become cloyed in time with cobwebs. The idea that such beautiful animals needed to become "part of the utilization process" stuck in my heart. And yet 50 or so such cheetahs turned into trophies each year might just make one or two ranchers think twice. And maybe this was a beginning.

The plane flew on across the desert, and it seemed to me that nature seldom offers easy or reasonable trade-offs. She is content merely to teach us one hard lesson, over and over, and nowhere more vividly than in Africa: All life comes from death. Below us wildebeests angrily tossed their manes, and springbok blithely grazed. Somewhere in the thorny brush a cheetah ambled, doubtless thinking, as we all must, about where it would find its next meal. □

Look for "Cheetah Chase" on National Geographic EXPLORER this month.

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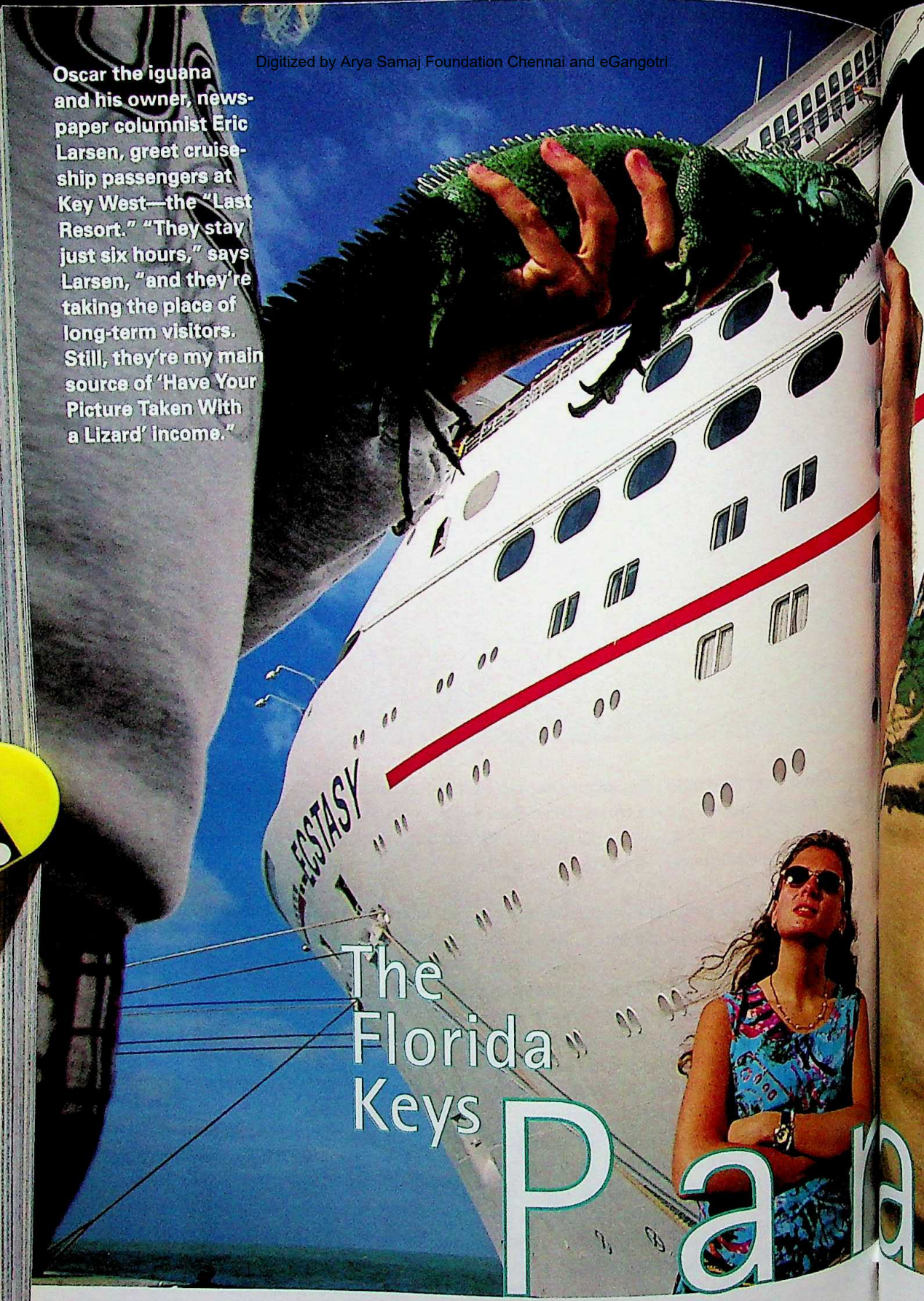

Oscar the iguana and his owner, newspaper columnist Eric Larsen, greet cruise-ship passengers at Key West—the "Last Resort." "They stay just six hours," says Larsen, "and they're taking the place of long-term visitors. Still, they're my main source of 'Have Your Picture Taken With a Lizard' income."

The Florida Keys

Para

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a d i s e

WITH ATTITUDE

BY FRANK DEFORD • *PHOTOGRAPHS BY* BOB SACHA

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Stuck on a sandbar, a skipper gets a tow from Duke Pontin's Spirit Marine boat-rescue service. "I had a feeling he wouldn't pay the bill—and he didn't," says Pontin. "But you can't leave someone in that kind of distress."

Conchs ARE MOSTLY DESCENDED FROM OPPORTUNISTS WHOSE LIVELIHOOD WAS BASED ON THE MISFORTUNE OF OTHERS.

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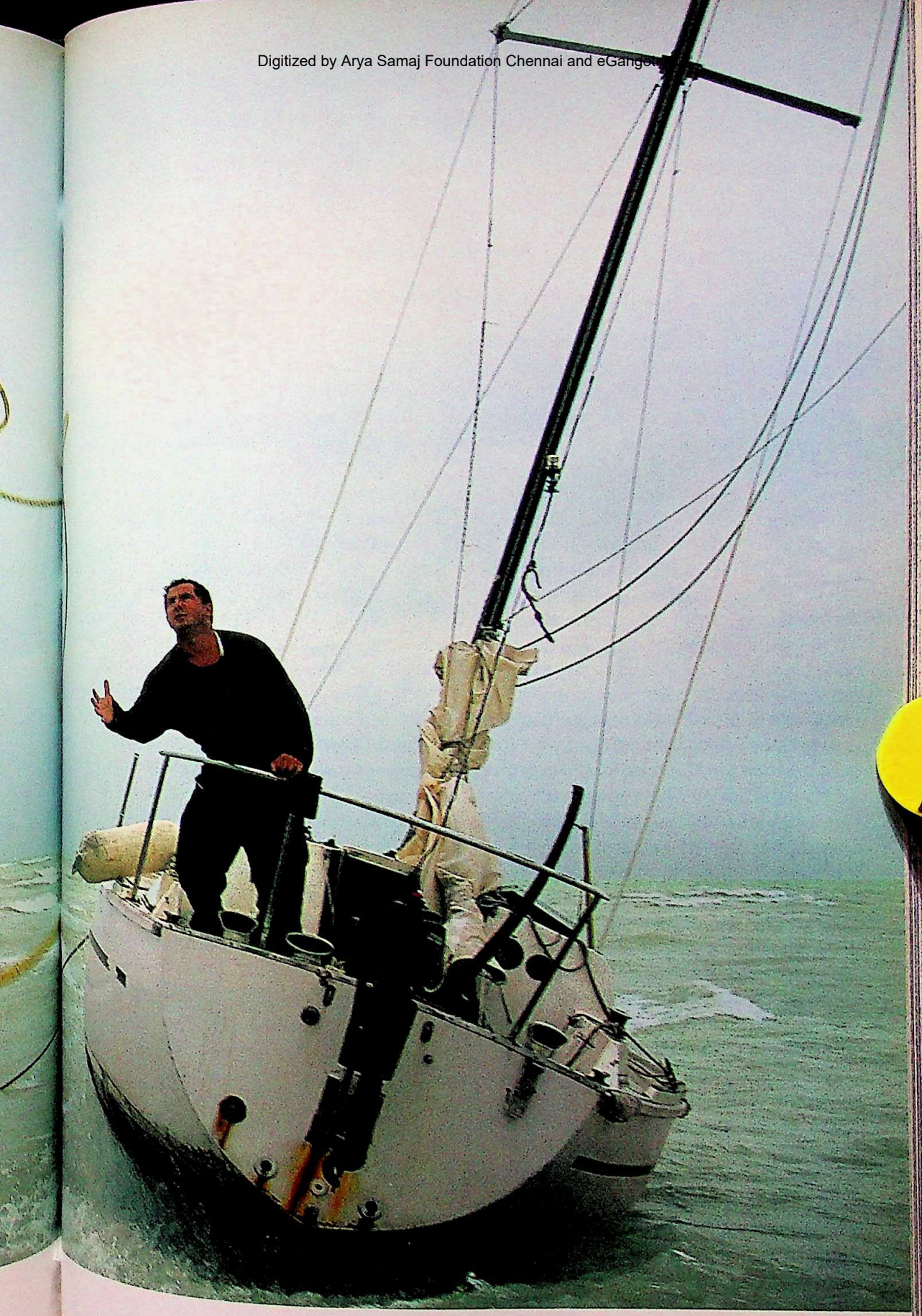

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Whereas it is generally accepted that, given the way the world turns, there are sunsets in every place on the face of the Earth, the Florida Keys—Key West, in particular—have presumptuously co-opted sunsets for themselves. Sunset in the Keys is an advertised tourist attraction, the clear implication being that you really can't see the sun go down anywhere else in the world.

But wait. It is not just that sunsets are indigenous only to the Keys. They also possess a special mystique. That is the green flash. Oh, you've never heard about the green flash of a Keys sunset? Well, it is rare. "I've only seen it once," says Sheila Mullins, the mayor of Key West, "but if you've seen it, you know it. If you're watching the sunset, and you say, 'Gee, I *think* I saw the green flash,' you didn't." Maybe the green flash is visible only one out of every couple hundred sunsets. It has to do with the refraction of the rays by the atmosphere on the low horizon of the Gulf of Mexico under just the right conditions. Or maybe it is just a Keysian Loch Ness monster. "Total bull," says Buddy Owen—he the proprietor of B. O.'s Fish Wagon, who has lived in Key West all his life. Or maybe . . . maybe you simply must believe in the green flash to see it.

Anyway, now it is once again nearing the daily climax, and at Mallory Square in Key West, the preferred vantage point, the throngs have assembled again to see the sun go down. Meanwhile, as it nears the end of its day's celestial path, there are more mundane sights in Mallory Square to inspect closer up: a fellow walking on broken glass, or his colleague swallowing a sword, or a strongman holding up a large grocery cart with his teeth. Etc. But, suddenly, all eyes turn away from these sideshow exhibits and look to the horizon, past the lazy ships and the noisy Jet Skis, to where that bright orange disk pauses just above the waterline, and then. . . .

Of course, the Keys have always been contradictory and done things their own way, to the limits—"pushing the envelope," as everyone invariably says proudly. For example, there's a spot of land, with a hideous marker, that is identified as the Southernmost Point in the Continental United States. Except, it's a lie. The genuine southernmost point is a few hundred yards away, but it's inaccessible to tourists with cameras. So Key West just picked a convenient spot. Or take key lime pie, which Craig Claiborne celebrated as "the greatest of all regional American desserts." Alas, as yummy as key limes are, none are commercially grown on the Keys.

But then, where exactly are the Keys themselves? Officially, they are a part of the great state of Florida. But residents of the Keys will have none of it. Key West even, tongue in cheek (maybe), declared itself a republic in 1982. Tony Falcone expresses the prevailing view.

A wet towel and a post-op rest in a wading pool are doctor's orders for a bandaged sea turtle being treated for a now common herpes-like virus at the Turtle Hospital (once a topless club) in Marathon. After a year's recovery, turtles are released.

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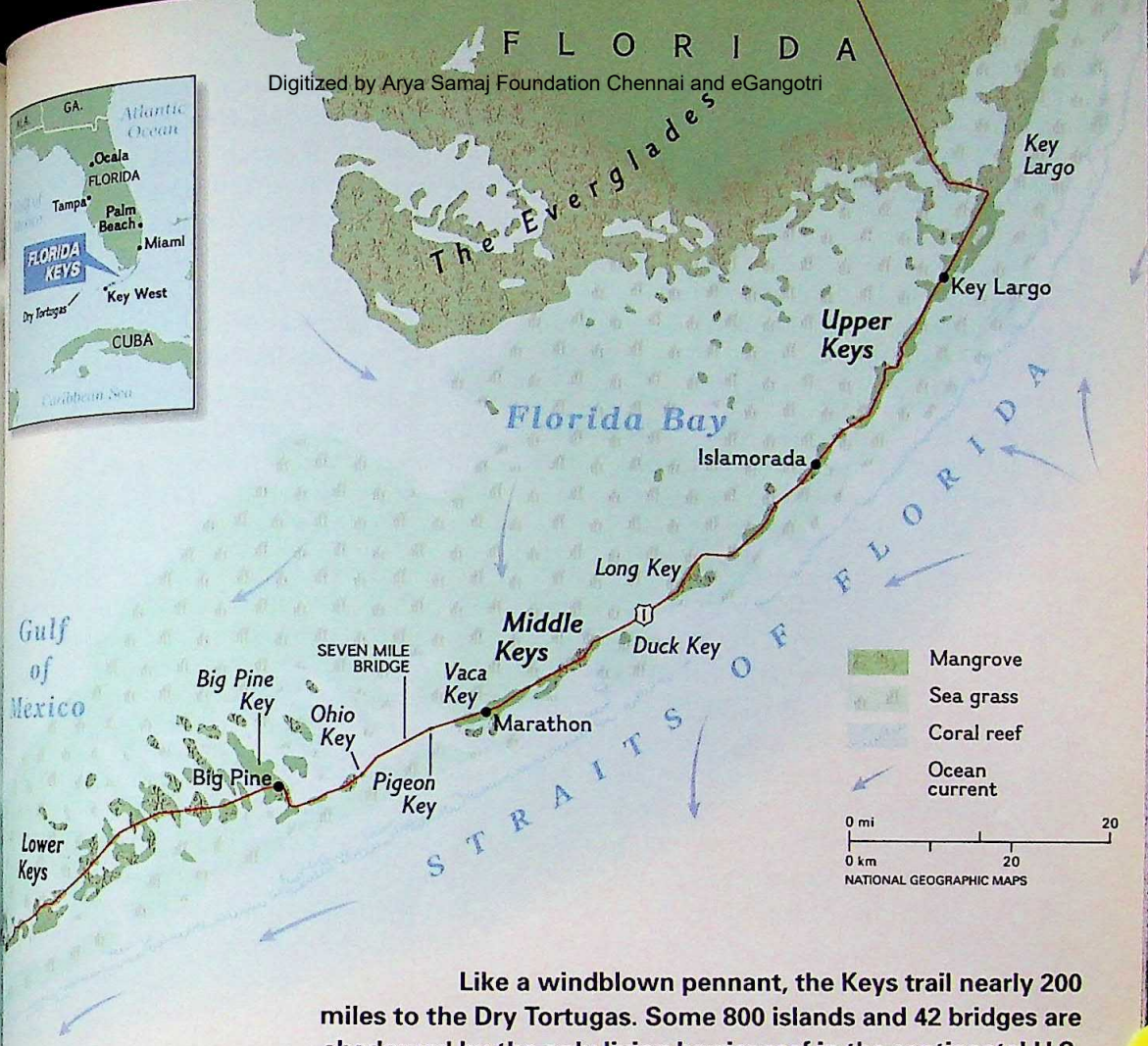

Like a windblown pennant, the Keys trail nearly 200 miles to the Dry Tortugas. Some 800 islands and 42 bridges are shadowed by the only living barrier reef in the continental U.S.

He runs Fast Buck Freddie's, which sounds like a back-alley junk emporium but is, perversely, upscale and glitzy. "Whenever I have to go to Miami," Falcone explains, "I always say, 'I'm gonna run up to Florida.'"

So instead of Florida, Keys inhabitants prefer to associate themselves with:

1) The tropics, and

2) Paradise.

One claim is wrong, the other infuriating. The Keys cannot be tropical, because even the real southernmost point is still 70 miles north of the Tropic of Cancer, where, officially, the tropics begin. But the Keys like being thought of as exotically Caribbean, just as all the foreign Caribbean islands want you to think that they're really stable and reliable, like the U.S.

Even more audacious is the assertion that the Keys are Paradise—capital P. It's a bit much, but then it's really quite amazing how many residents speak of their introduction to their Paradise in the most genuinely mystical terms. You would not, for example, normally associate the poetic with Rudey, so called, she in leather with her signature handcuff accessories, who presides over the Rude Awakening Radio Extravaganza Ministry mornings on WEOW on your FM dial. Rude Girl earned that sobriquet for her predilection to flatulence *on the air.* But, lyrically, she speaks: "The first time I came here, I sensed that the atmosphere was magical. There's such an incredible lightness to this place." More regularly, others invoke the image of home. For example, says Carol Shaughnessy, who once ran the Hemingway Days festival, "I think Key West will recognize *you* if you're meant to be here. I came here 20 years ago, and I was just walking alone, and suddenly I realized for the first time in my life, I was home."

Best known as a sportswriter, FRANK DEFORD is also a commentator for National Public Radio. He last wrote for the magazine on the cultural roots of sports (July 1996). BOB SACHA won a 1999 Alfred Eisenstaedt Award for Magazine Photography for his February 1998 GEOGRAPHIC article, "Revolutions in Mapping."

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Why, that almost sounds like someone describing how she fell in love.

"Yeah," says Shaughnessy ingenuously, "I think you could say that."

Key West is a city of cats—prominently featuring those supposed descendants of Hemingway's six-toed types. They're everywhere, and, says Tony Falcone, patting his own stray, Bones, "The cats choose the people here, not the other way round." Like that, the place and its human denizens seem to find each other. It is an article of faith, regularly expressed, that Key West possesses a different barometric pressure from most every place in the world (Paris and San Francisco excepted). And a green flash at sunset. Sometimes. Maybe.

Key West is extremes. It has been the richest city in the United States and so poor it went bankrupt. Right now, says Ed Swift, a promoter and entrepreneur, perhaps the most controversial man in town, "We have a new contradiction. We're too rich, but we're too poor."

On the other hand, the rest of the Keys—"the outside Keys," as the insiders of Key West dismiss them—have, until very recently, never been much of anything. At the turn of the century less than a thousand people lived in the 110 miles between Key West and the mainland. Even as late as 1960 there were only about 14,000 mavericks and fishermen hunkered down along the chain. Now: upwards of 55,000. Even the Spanish conquistadores, who never saw a virgin piece of land they couldn't find reason to violate, took a pass on the outside Keys—perceiving them (fairly accurately) as 800 flat bits, full of nothing but mosquitoes. The Keys were like a cheap, ugly watch chain, with a magnificent gold piece on the end, ticking to its own time.

Only now, at last, are the chain and the watch in it together. The outside Keys are very much afraid that they are going to become just like Florida, while Key West has an even greater fear. It worries that it is going to suffer the worst fate of all: that it might become ordinary.

Key West has always prided itself on being hospitable to those who might not be accepted elsewhere. Famously now, of course, Key West features a large gay and lesbian population. But, in the past, other folk from without the mainstream have found comfort here. Rumrunners and drug smugglers have been, at times in this century, honored citizens. It is not disputed that back in the 1970s, after the Navy pulled out much of its force, the lower Keys were kept alive by drug traffic. It was cash-and-carry. Everybody winked; marijuana bales were referred to as "square grouper." Before that, in the days when Hemingway drank at the Blind Pig in Key West, it was booze. Wilhelmina Harvey, who was elected county commissioner promoted only as "Wild Willie," recalls, as a girl, seeing mysterious green and red lights out in the ocean. Then she would hear a fire bell ring over on the Gulf side, and as the citizenry rushed off to put out the alleged blaze, the rumrunners (or Scotch runners from Nassau) would take advantage of the diversion and sneak in the contraband. "It was such a precious place," Wild Willie recalls fondly.

Like Australians, heirs of convicts, those born in Key West, who are known as Conchs (pronounced konks), after the large mollusks, are mostly descended from opportunists whose livelihood was based on the misfortune of others. Every year dozens of ships—most sailing the trade route between New York and the Gulf ports—would smash onto the great reef, and when the cry would go up "Wreck ashore!" most every ambulatory male would rush to his boat to see what he might salvage.

There is even the legend of the wily Squire Eagan, a Methodist minister who, from the vantage of his pulpit, saw a ship founder on the reef one Sabbath morning. The good preacher, who doubled as a wrecker (didn't everybody?), promptly began to read from First Corinthians, departing the pulpit, striding down the aisle: "Know ye not that they which run in a race run all, but one receiveth the prize? So run, that ye may obtain." Only then, as he approached the church door, did Squire Eagan cry out "Wreck ashore!" whereupon he rushed to his schooner (appropriately named *The Godspeed*) and, with his head start, reachethed the prize first.

Before Henry Flagler built his railroad to Key West in 1912, many visitors arrived there unintentionally, as human salvage. Wild Willie's own grandmother, a German immigrant bound for New Orleans, was on a ship that hit a reef in 1858. The wrecker who saved her married her. But that was at the end of an era. More modern lighthouses and more controllable steam

(Continued on page 44)

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Privately owned Ohio Key offers an RV resort and marina; Atlantic-side wetlands are protected by county zoning. Elsewhere in the Keys national wildlife refuges encompass 416,000 acres, most of them water.

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THREATS

COASTAL DEVELOPMENT: Despite laws designed to protect mangroves, landowners and developers still cut them down to improve waterfront views and make room for docks and marinas.

HURRICANES AND STORMS: Natural hazards occasionally claim small stretches of mangroves.

THREATS

WATER QUALITY: Inadequately treated sewage and storm-water runoff carrying pollutants from developed areas put excess nutrients into the water and create algal blooms, which prevent sunlight from reaching sea grass beds.

PROP SCARRING: In shallow waters rapidly turning propellers can carve grooves that grasses cannot easily repopulate, leading to bottom erosion.

DREDGING AND TRAPPING: Both intentional removal of sand to deepen channels and accidental dragging of anchors uproot sea grasses. Lobster and crab traps pulled across the beds also destroy them.

Mangroves

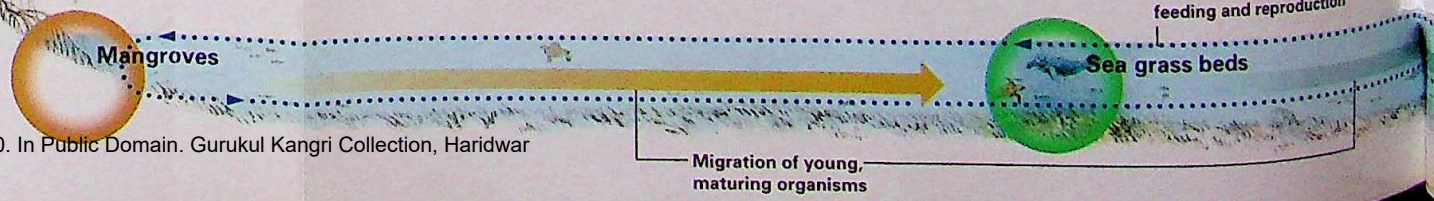
Lining the shores of the Keys, saltwater-tolerant mangroves, with their tangled roots and dense branches, absorb wave action, stabilize coastlines, and prevent erosion of inland soil. Mangroves act as a nursery for fish, mollusks, and crustaceans, collecting nutrients the animals need by trapping organic matter. A major component of this detritus is decaying mangrove leaves themselves, broken down by bacteria and fungi. Above the waterline, key deer forage on mangrove leaves, whose limbs shelter nesting seabirds.

Sea grass beds

The only flowering plants to live their entire lives in seawater, sea grasses are an important contributor to the coral reef ecosystem. Grasses are a major food source for sea turtles, manatees, and fish and a nursery for fish, lobsters, shrimps, horseshoe crabs, and mollusks such as conchs. Sea urchins eat algae growing on the grasses; sea cucumbers filter organic debris. Just as mangroves hold the shoreline in place, sea grass roots help stabilize the shallow sandy bottom.

Connected worlds

The coral reef ecosystem of the Florida Keys extends from the shoreline, where mangrove roots nurture newborn fish and other marine life, as do sea grass beds. Several species, such as the spiny lobster, migrate to deeper waters as they grow, and many adults range between habitats to feed and reproduce. Mangrove roots filter pollutants from water to promote healthy sea grasses, which in turn absorb nutrients and trap sediment that would damage coral. Healthy reefs block wave action, protecting grass beds and mangroves.



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THREATS

WATER QUALITY: Corals require clean, clear water to survive. Algal blooms caused by the excess nutrients that threaten sea grass beds also damage corals. Sunlight cannot penetrate clouded waters to activate photosynthesis in the corals' symbiotic algae. Numerous diseases—whose causes are debated—have spread in recent years.

OVERFISHING: As fish numbers decline, the delicate predator–prey balance is upset.

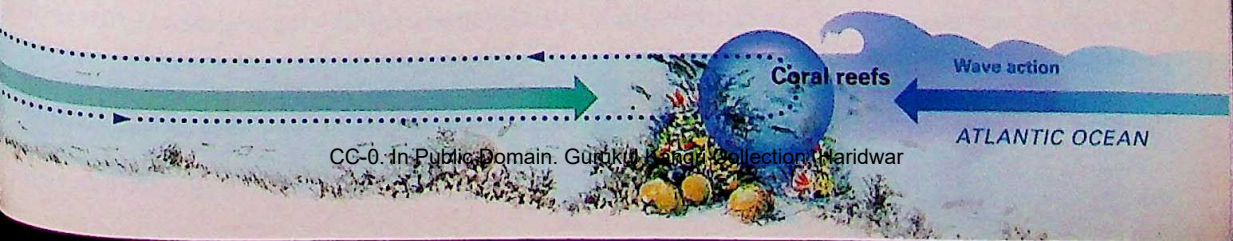
PHYSICAL DAMAGE: Boat anchors, grounded vessels, and intentional chipping for collections can destroy entire coral colonies.

POLLUTANTS: Leaking petroleum products and antifouling paints applied to boat hulls can be deadly to corals.

Coral reefs

Among the most biologically diverse ecosystems, coral reefs are built up by layers of calcium carbonate, the accumulated skeletons of billions of tiny soft-bodied sea animals called coral polyps. Inside living polyps, algae called zooxanthellae provide oxygen and organic compounds and in turn receive carbon dioxide and nutrients from the polyps. The algae also give corals their color. Reefs are a habitat for an array of sea creatures: jellyfish, sponges, anemones, snails, rays, crabs, lobsters, sea turtles, moray eels, and some of the world's most colorful fish.

ART BY CHRISTOPHER A. KLEIN, NATIONAL GEOGRAPHIC ARTIST



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vessels wrote *finis* to what was called "the jolly and carefree" wrecking life.

At other times Key West prospered on account of the sponges and turtles in the water or the cigar tobacco from Cuba. Indeed, until Castro, that neighbor island always held a powerful influence over Key West. A failed 1868 war against Spain brought large numbers of Cuban expatriates to town, where they were welcomed into the same polyglot society that had embraced Bahamian loyalists, Connecticut sea scavengers, and whatever other scoundrels and pirates and accidental visitors were brought there (in one way or another) by the enchanting reef. A quarter of a century later José Martí came to Key West and gave an inflammatory speech of revolution from a balcony at what is now a gay nightclub called the Treetop Cabaret.

Key West was maintained as a Yankee outpost during the American Civil War, but much of the city's gentry remained largely sympathetic to the Confederacy. However, Key West's slave heritage was ameliorated by its historic tolerance; white and black were buried in the same cemetery, and a black judge was elected barely a decade after Appomattox. "Key West is the freest town in the south," editorialized the *New York Age*, a black newspaper, in 1888. Gays are part of a long tradition.

Yet, in counterpoint to the cosmopolitan openness of the town, Key West retains the most curious devotion to birthright. You must be born on the two-by-four-mile island to be a Conch. Oh, live there long enough and they'll patronize you and call you a "freshwater Conch," but outsiders who marry Conchs and live in Key West for decades forever remain no more than "the stranger" so-and-so married. When Sheila Mullins ran against a Conch in '97, her opponent, Hilario "Charlie" Ramos, dismissed her as "a newcomer." Mayor Mullins has lived in Key West for a quarter of a century.

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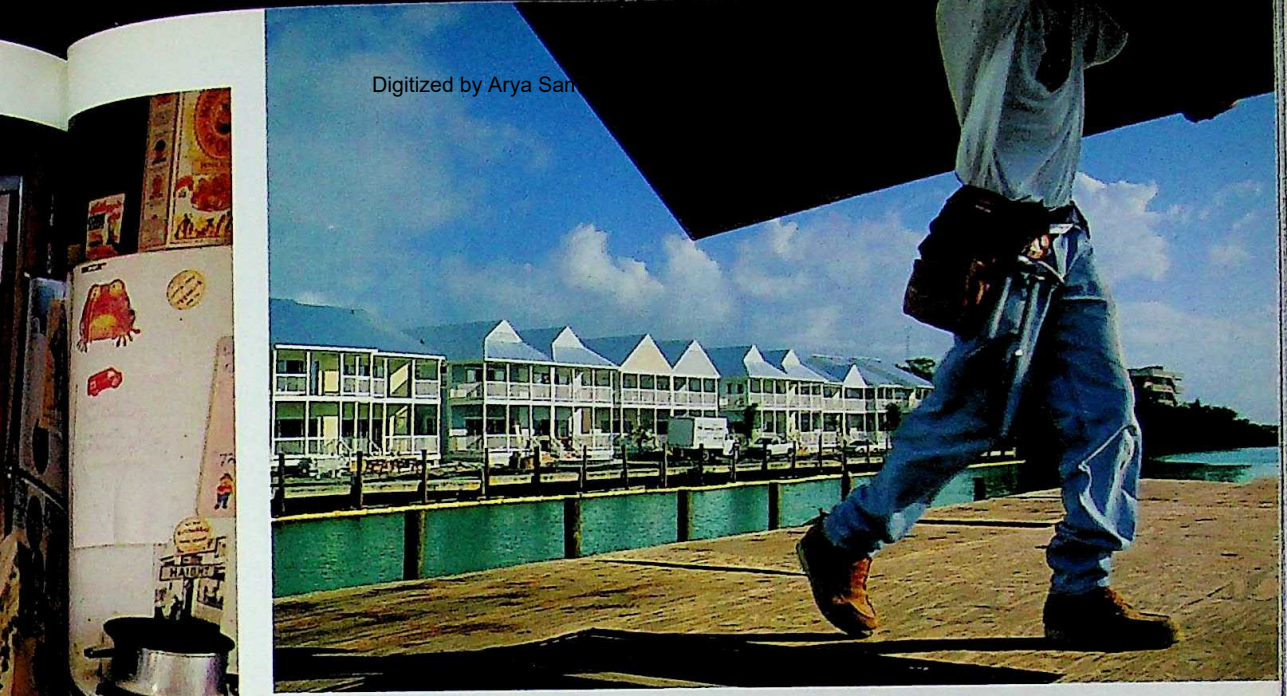

Soaring housing costs in the Keys have crammed low-wage earners together. Four people make ends meet sharing a floating home on Key West's Houseboat Row (left). For those with bigger checkbooks, new town houses on Duck Key (above) range as high as $400,000.

All the Keys are so geographically skinny—and now so demographically crowded—that as Connie McSorley, a real estate agent who lives on Big Pine Key, says, "It's the longest small town in the world." To Tony Falcone, it's not a town at all but a college campus for grown-ups. Anyway, the Keys always worked, it seems, because even though everybody knew everybody else's business, nobody cared much what business a neighbor was taking care of. Everybody was a Bubba. You have to be born a Conch, but you could be accepted as a Bubba.

For example, Buddy Owen, who is a Welsh-Cuban Conch, grew up with Boog Powell, the great baseball player, who came to Key West as a child. So Boog could never be a Conch, but he was an A-1 Bubba. "Bubba means Brothers United in Building a Better America," Buddy says at his Fish Wagon on Caroline Street, which is a sort of one-man theme park of a restaurant. He and Boog would stay up late, then fish early for their breakfast from the pristine Keys water, where, it is said, some 500 species of fish roam the coral.

Today, though, Bubba has largely become a term of disparagement—a clubhouse pol, a con, a crony, that type. The newcomers don't like Bubbas. "The place has lost its soul," Charlie Ramos moans, even though he's quick to volunteer that he's made a lot of money renting property to the allegedly soulless arrivistes. A lot of other Conchs unloaded their houses and left when the tourist boom accelerated. They moved, many of them, up to Ocala, in Florida, such an emigration that it was like Ireland to America. They have Conch reunions regularly in Ocala. But the displaced Conchs can't afford to move back, even if they wanted to.

Sheila Mullins bought a house for $7,000 in '76. Now that kind of property is worth in the hundreds of thousands. Many old-timers have to pay more in taxes and insurance annually than the whole house cost them. In a service-based tourist economy, there's no place the service people can afford to live—especially as rich vacationers buy up residences as second homes, then rent them out much of the year to other rich vacationers. And, mournfully, at his Fish Wagon, Buddy Owen shakes his head. "The Conchs have changed," he says. "Now, they just work and go home. Basically, you see, most Conchs can't afford to go anywhere in their own town."

The cruise ships pour people in almost every day, and they drink where Hemingway did and buy T-shirts. Very few of them could even

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Getting a handle on the ecosystem, two snorkeling students hang from the rail of a boat run by MarineLab of Key Largo's Marine Resources Development Foundation. More than 6,000 students set sail each year to learn about the Keys' coral reefs and marine life.

imagine a green flash. IF IT'S REALLY THE "SEASON," asks a bumper sticker, WHY CAN'T WE SHOOT THEM?

The lesson is that paradise will always be lost wherever it comes up against real estate values.

Key West has never been a beach resort. Indeed, because of the reef there is no surf, and most of the sand has to be imported. It's almost a coincidence that the place happens to lie only 24.5 degrees north of the Equator. Rather, it's always been a destination measured by its people and its ambience. Nobody has ever understood that better than Jimmy Buffett, who, failing to make it in Nashville, created his Margaritaville out of Key West. Carol Shaughnessy, who worked for the live Buffett before she started working for the dead Hemingway, says, "Jimmy was selling a mystique. His songs talk of a life that everybody wishes they could live." She pauses, and says wryly: "Well, maybe a life they *think* they would like to live."

Anyway, Jimmy Buffett has moved to Palm Beach and merely keeps a second home in Key West. Ed Swift says, "I sold Jimmy his first electric guitar. You know, he and Hemingway share something. They both liked this place for the same reason. They both had a lot of money at times when nobody else here had any."

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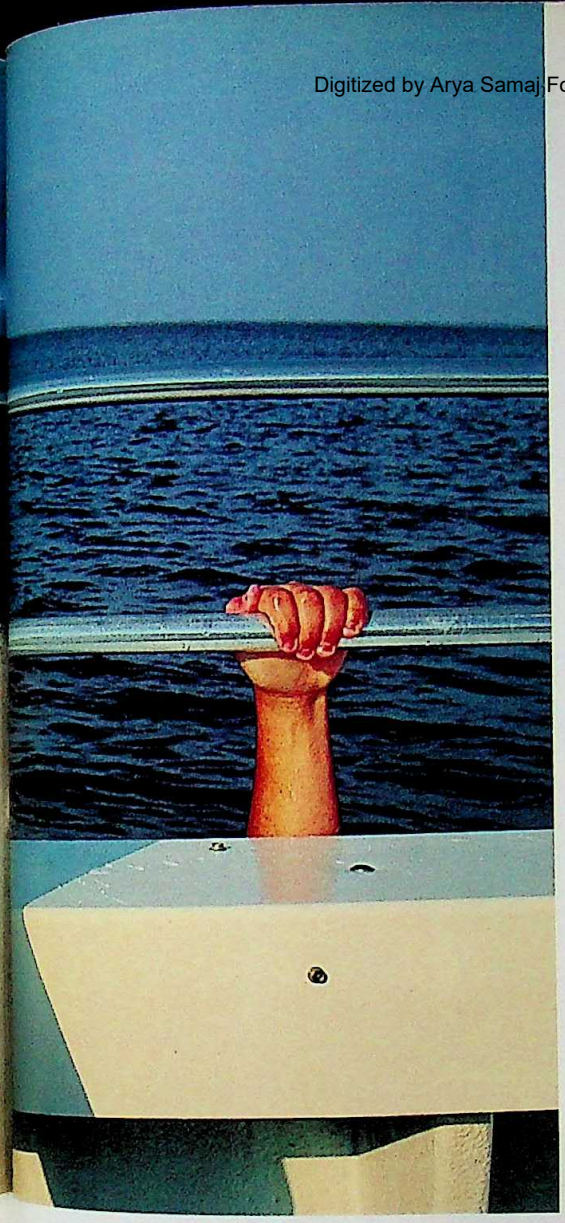

Nevertheless, even if Buffett is gone to Swellville, his Parrot Heads still migrate to his shrine in Key West, next to Fast Buck Freddie's, there to drink the margaritas and drink in the atmosphere. Key West is metaphysical.

The rest of the Keys are more typical in their sunshine attraction. Also, their own battle now is a familiar one: Sleepy little Dixie backwater fights not to get turned into a charmless suburban strip mall. Developers take on environmentalists! Return bout! (The 20th-century version of ranchers vs. sheepmen.) "But this is like Yellowstone!" Dagny Johnson, the president of the Upper Keys Citizens Association, cries out, as she steers her wheelchair around her bayfront house, hell on wheels, rousing her troops against the enemies of nature. "This is one of the longest reefs in the world. We *can't* let them destroy this place."

In particular, here on Key Largo the fight is against widening a highway to make the access to the Keys from Miami easier and allowing a casino boat to continue to operate outside the three-mile limit of the state's jurisdiction. But it's still inside sanctuary waters—flopping about like a leviathan, occasionally banging into the dainty coral reef . . . which starts the process of changing God knows what else in this omniconnected territory. Belowdecks, the gamblers pull slot machines, no more aware of where they might be than if they were in Monte Carlo or on an Indian reservation.

One of Dagny's men-in-arms, Joel Carmel, a bookstore owner, says, "This is all so tacky. What we want to attract is ecotourism, and gambling—a gambling boat on a reef!—is simply not compatible." Surveys have shown, in fact, that what visitors to the Upper Keys most want is diving, fishing, and bird-watching, but Key Largo is already close enough to Miami to be an exurb and, like it or not, is being auditioned for suburban status.

Meanwhile the other major ecological dispute on the Keys takes place near the other end, where Big Pine has much the same relationship to Key West as Key Largo does to Miami. Only on Big Pine the fight is not over the reef but over another living thing: key deer.

Big Pine is sort of the continental divide of the Keys. The islands north of it—called, blandly, just the Middle Keys and the Upper Keys; remember, they were only so many nondescript clumps on the way down to Paradise—are formed, like the mainland, of limestone. But starting at Big Pine, the Lower Keys and Key West itself are overlaid with pock-marked oolitic limestone. Anyway, 15,000 years ago, toward the end of the last ice age, the Keys were still bridged to the mainland, but as the seas rose, Virginia white-tailed deer, which had moved about as far south as they could (just like *Americanus retiredus* today), found they were trapped there when the glaciers melted. The deer adapted to their environment by smalling down and enjoying having Big Pine to themselves; as recently as 1950 fewer than ten humans called it home.

Now the number is approaching 5,000 and would soar well past that if Monroe County,

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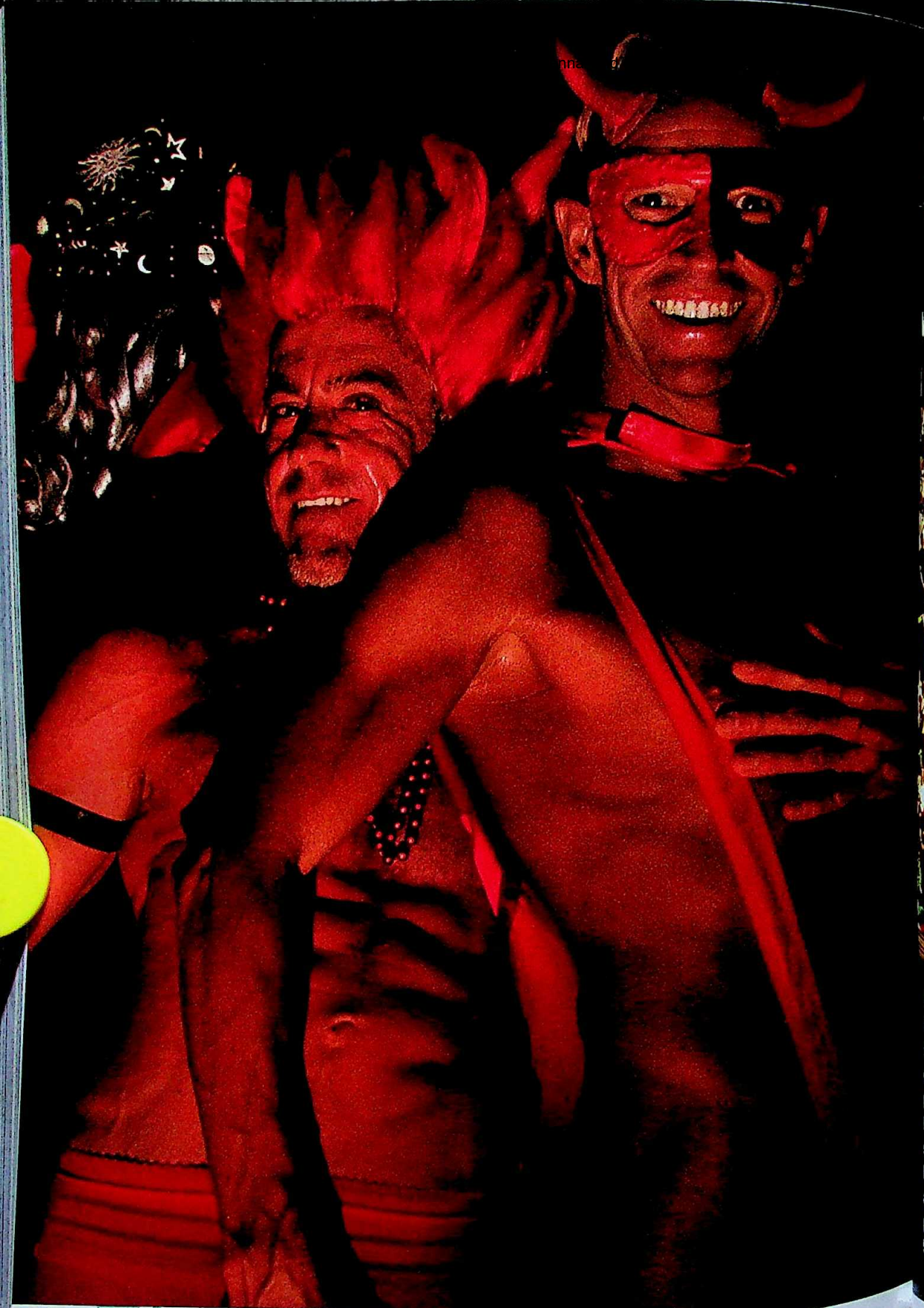

The Keys HAVE ALWAYS DONE THINGS THEIR OWN WAY, TO THE LIMITS— "PUSHING THE ENVELOPE."

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It's loud. It's lewd. It's gay. It's straight. It's Key West's ten-day-long Halloween party. Fantasy Fest heats up fall tourist season with the Headdress Ball (left) and a flamboyant parade that draws 50,000 people.

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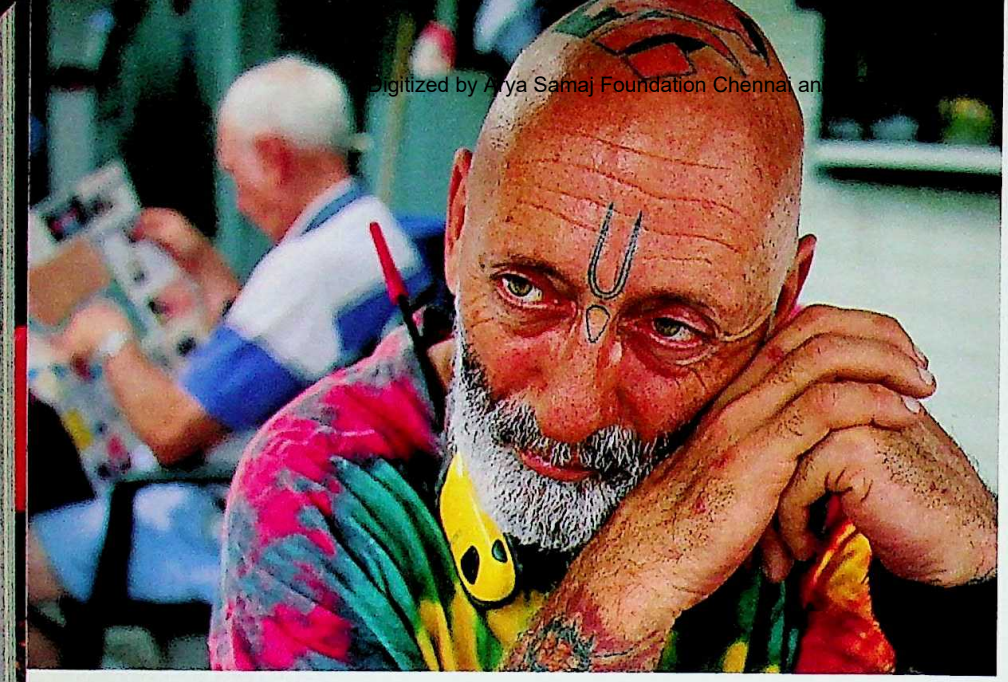

Why did the rooster cross Duval? Maybe he knew that a law protects descendants of Key West's once popular fighting cocks. Such quirky acceptance of the unusual attracts free spirits like Richard Vore (above), who works the graveyard shift at a joint called, simply, The Bar.

which encompasses the Keys, didn't limit growth. Barry Stieglitz, the U.S. Fish and Wildlife representative who runs the deer refuge, pulls out an aerial photograph showing how the humans have encroached. Stieglitz is a second-generation conservationist, and he speaks softly but passionately. "The deer were here first," he says, "and they're part of the building blocks of the world."

A lot of the little creatures get hit by cars and killed by big family dogs. Moreover, the key deer are in conflict with the single other attraction that Big Pine is most famous for, which is . . . a flea market. The flea market folk and many residents want an extra lane added to the two existing ones, while Stieglitz and his deer defenders argue that 50 percent more road will mean something like 50 percent more roadkill. Money has already been appropriated for underpasses for the deer.

"It's like being under Hitler down here," says Connie McSorley, the former president of the Federation of Chambers of Commerce for all the Keys. "We're as precious a resource as those deer are, and we *are* environmentally conscious. We just want to share the land we have, but the deer have all the rights. You can't give 'em away, because every zoo knows they're nothing but little Virginia whitetails. Sure, they're cute enough. They're even on our chamber logo. But they're just dwarfs."

So, as ever, the battle lines are drawn, and it is hard to find someone in the middle—such as Richie Moretti of Marathon in the Middle Keys. Moretti owns a tourist business, the Hidden Harbor Motel, but he also owns a turtle hospital. "Isn't it funny?" Moretti observes. "I came down here to relax and kill fish and ended up working to save turtles.

"Look," he says, picking up a turtle out of a round tank, "without the environment, there's *no* economy here. The reef dies, my motel dies. And then I can't pay to save the turtles. You see? The fact is, when you see only the animal point of view, there's a backlash, and you hurt the animal. But when you see only the human point of view, you kill the animal."

The environmentalists in the outside Keys are fighting at some disadvantage, though, inasmuch as the battleground isn't particularly pretty, and the part that everybody sees—U.S. Route One—is hopelessly tawdry. It isn't exactly like trying to keep a McDonald's off Mount Rushmore. Most Caribbean islands possess the critical mass to offer some backdrop and variety, but the outside Keys are the

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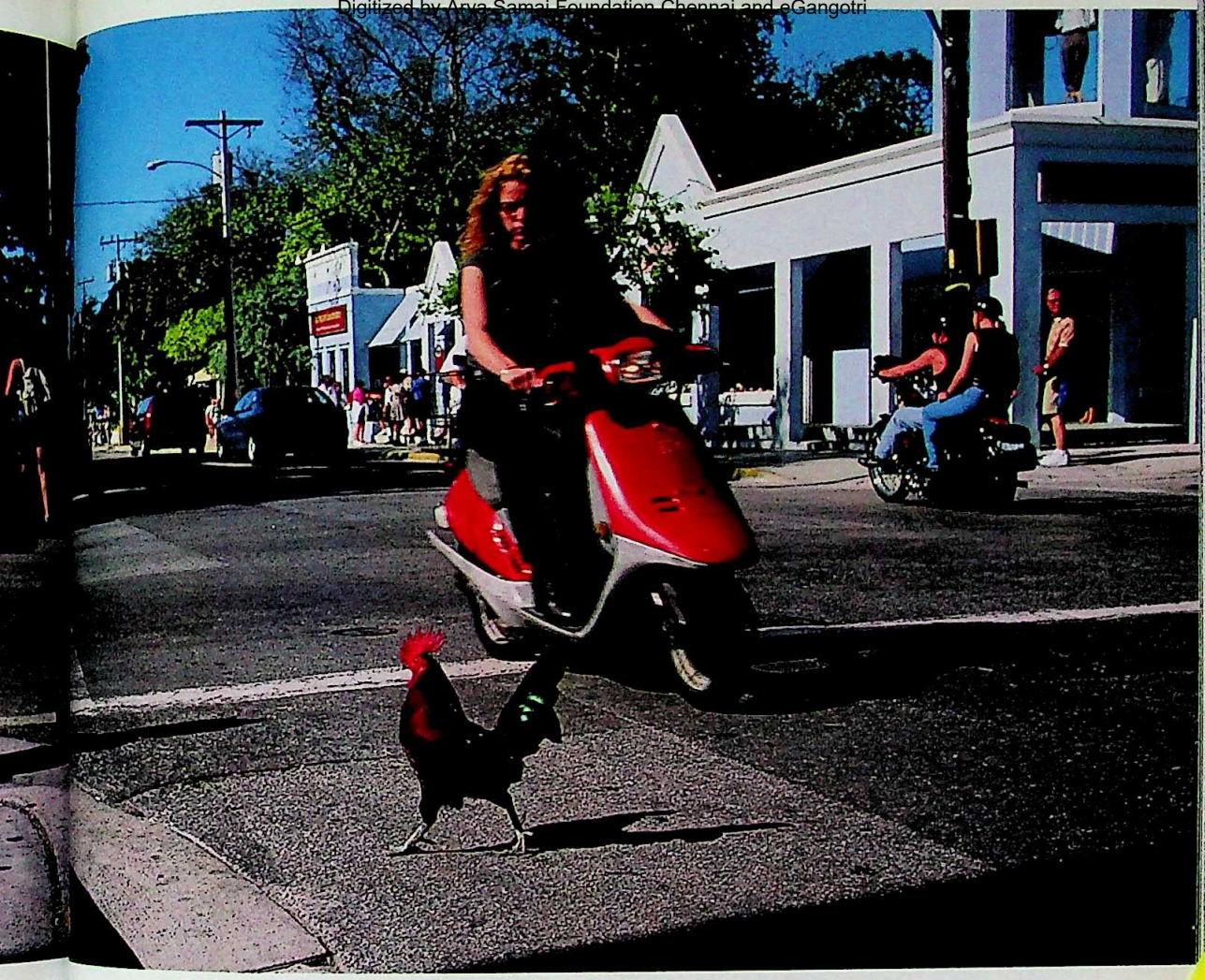

Jersey shore with palm trees; it's no wonder, really, that everybody has been trained to look away, to the sunsets.

The true beauty and strength of the Keys is largely unseen, lying underneath the Atlantic Ocean on one side and Florida Bay and the Gulf of Mexico on the other. And down there it's all so . . . fragile. Consider: When Flagler built his incredible railroad line to Key West—"Gateway to the Panama Canal"—engineers found it easier, in many instances, to fill in the shallows between islands rather than build bridges. One tiny little speck among the 800 or so islands is Pigeon Key. Here 400 railroad workers lived for four years, building the Seven Mile Bridge—the longest in the world at that time—and here now is a museum run by a Ph.D. named Dan Gallagher, who identifies himself as a hybrid, an environmentalist-historian. But it's the proper mix here. Gallagher explains how the land bridges that Flagler's men made began to alter the balance of salt water and fresh water in Florida Bay, an estuary. Then decades of canal building in the Everglades significantly lowered the inflow of fresh water. As a consequence, the bay's sea grasses are now mostly limited to turtle grass, accommodating to the saline arrangement that man has created.

Then there's the impact of pollution. "Look," Gallagher says, grabbing for a map that shows how algae periodically blooms in the bay. And now—"Look!"—here and there it has drifted under the bridges, out into the ocean, where sometimes it hovers above the reef. Dark. Oblique. "Coral needs sunlight to live," Gallagher explains. "Algae can block it out, and. . . ." He shrugs.

The reef is the one common ingredient. It matters to everyone, from Key Largo, where the gambling ships lug slot machinists out to the coral, down through the spreading algae

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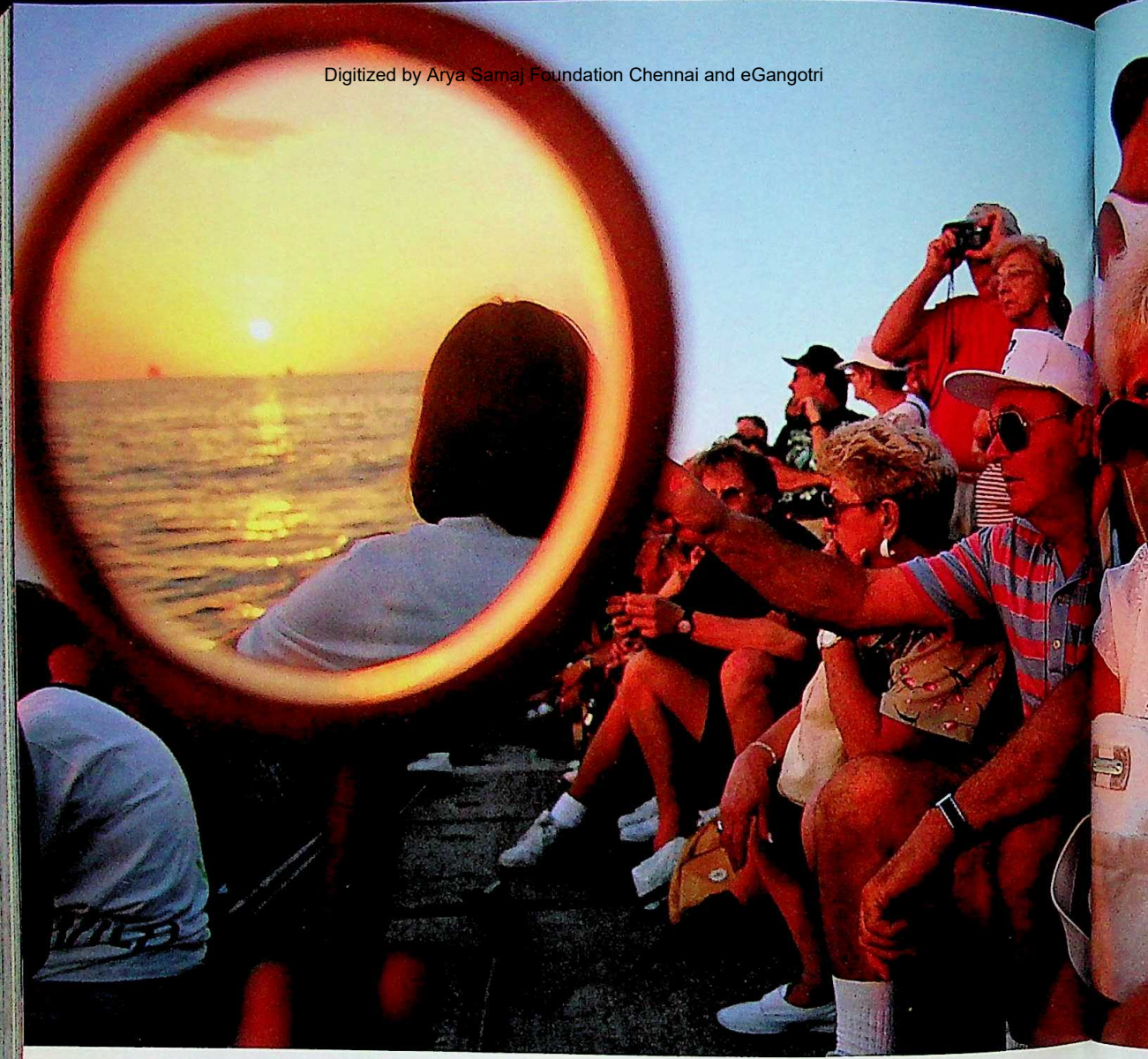

A mirror captures one of the two most popular shows in Key West: the sunset from Mallory Square and the crowds who come to applaud it. Many swear they see the elusive green flash at sunset's end. Key West's own flashy ways never end—they just keep costing more.

to Key West, where the charter boats take out maybe 400 amateur divers every day. They're supposed to have been advised not to touch the coral, but a lot of them aren't educated by the captains, and a lot more don't pay attention anyhow.

As boys, Buddy Owen and Boog Powell used to have the Key West reefs all to themselves, but then Boog went off to Baltimore to hit home runs and become Most Valuable Player, and Buddy kept diving, until, all of a sudden, late in the sixties, he started seeing some kind of green slime by the coral. "It was like a haunted house out on the reef, you know?" he says. And now Buddy reports: "There's not a sign of life left there, on the Gulf side of Key West." After eons, it all happened very quickly.

And if more and more coral continues to be destroyed? "Well," says one resident, "then the Keys become nothing but a land of sunsets and bars."

Highway One mile marker zero—2,593 miles down from Fort Kent, Maine, at the New Brunswick line—sits at the corner of Whitehead and Fleming, between the Hemingway House and the Little White House, where frequent visitor Harry Truman ran the country by day, while drinking bourbon and

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playing poker by night. But a block over from Whitehead is Duval Street (rhymes with "gall"), which has always been the heart of Key West, physically and metaphorically.

The tourist trolleys and trains beeline to Duval. The pedicabs and pink taxis ply the street. All the cruise-ship tourists troll Duval. Margaritaville and Sloppy Joe's, where Hemingway was at home, and Diva's, where the drag queens lip-synch, and Ripley's Odditorium (never mind), and the Oldest House and the tallest building and the grandest church and the Southernmost House all are on Duval (rhymes with "mall"). But also now, the Hard Rock Cafe, Planet Hollywood, Hooters, and a plethora of T-shirt shops line Duval (rhymes with "appall").

In a sense Key West has become the victim of its own runaway success. Out-of-towners speculate in houses, and the rental rate is so high on Duval Street—up to $100 a square foot—that the only shops that can afford to lease there sell generic merchandise and experiences. Wonderful little galleries that made Duval Street special have, too many of them, been squeezed out by the myriad T-shirt shops. Nobody understands how so many of the same downscale bazaars, selling the same vulgar apparel, survive.

Key West is still precious. And it's still contradictory. "They call it Paradise," says Barry Stieglitz up on Big Pine. "Well, soon it's going to just be Paradise for the Super Rich." Or Ed Swift: "This is the Ellis Island of the Caribbean, and it has the lowest incidence of prejudice you'll find anywhere." Certainly the good times have always alternated with the bad. The lighthouses stopped the wrecks, and labor unrest sent the cigars to Tampa; enlightenment ended the business in turtles; Uncle Sam decided it really didn't need its own Gibraltar anymore. But always Key West has come back, and always, too, its soul has been up for sale.

But now it is approaching sunset again, and the people are thronging to Mallory Square. Many of the citizens of Key West still watch the sunset regularly. They are not jaded at all. Tony Falcone rides his bike to a special, quiet place he has found. He used to watch with Bill Conkle, his partner at Fast Buck Freddie's, but he died last year. Bill Conkle is one of the names on the AIDS monument at White Street Pier. The sun pays its last call of the day there too, kissing all those names good-bye.

But most of the sunset spectators are jammed again onto Mallory Square, waiting for the moment. Now the sword swallower and the glass walker pause in their divertissement, because all eyes in Key West have departed them to search the horizon. And there the bright Keys sun offers a final salute, and it begins to dip below the water until, pfftt, it is gone.

If you were not absolutely, positively sure there was a green flash tonight, then there was none. So, come back tomorrow or the next evening, for the sun always sets, fondly, upon the Keys, at the end of the road, just up from the tropics, on one side or other of paradise. □

Listen to Frank Deford tell tales from the Keys at *www.nationalgeographic.com/keys.*

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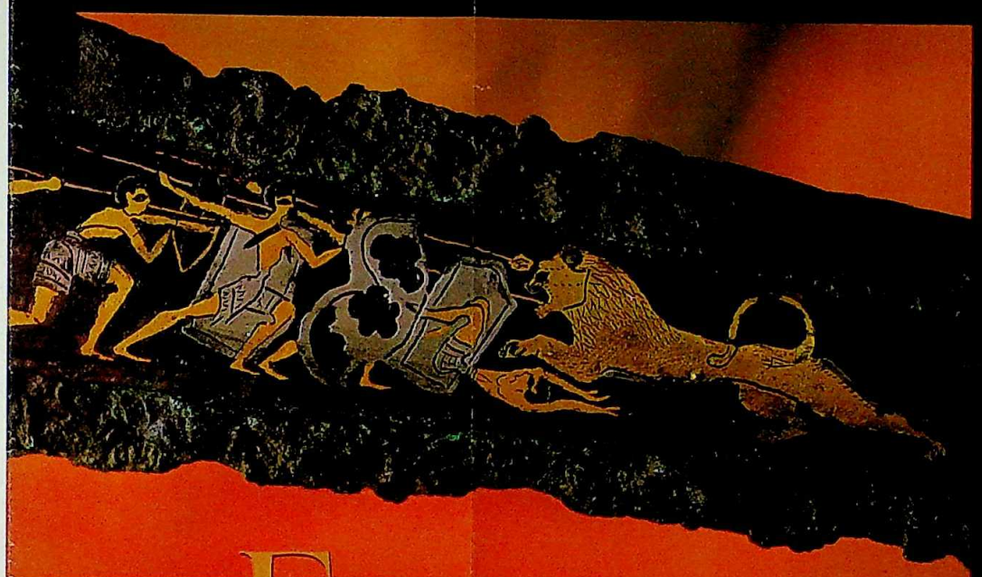
Deadly conflict in silver and gold leaps from the pitted blade of a bronze dagger found buried at Mycenae. That ancient citadel led Greek armies against Asiatic Troy in Homer's Iliad. *Though Trojans fought like "ravening lions," they lost that fabled Bronze Age war. Modern archaeology hints that Homer's tale may be more than myth in this first of a three-part series on ancient Greece.*



ECHOES *of the* HEROIC AGE

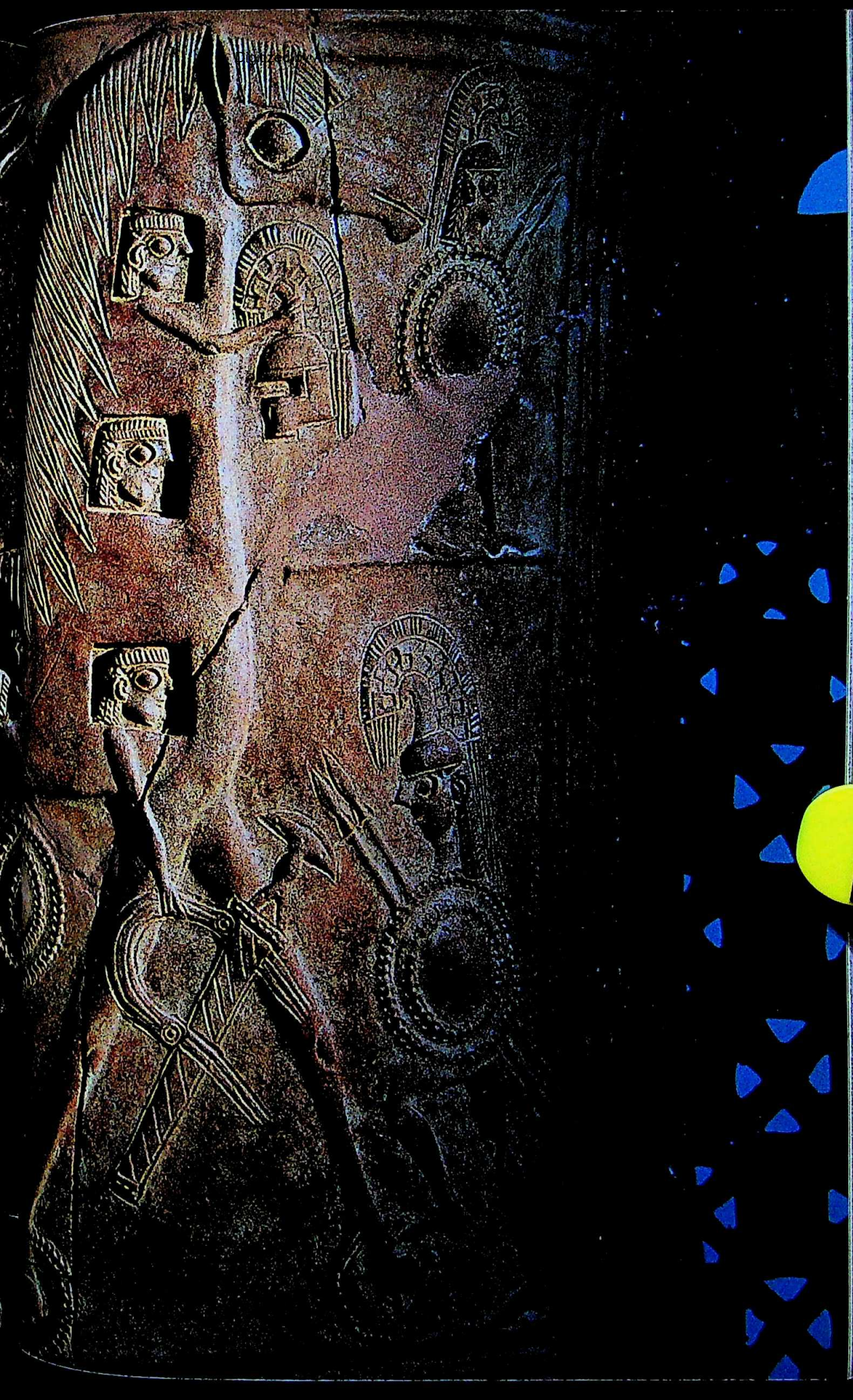
ANCIENT GREECE PART I

By CAROLINE ALEXANDER

Photographs by JAMES L. STANFIELD

"Myth often has a historical truth at its center," says Nikoletta Demopoulou of Athens (above). Central to the tale of Troy was the seduction of "lovely-haired Helen," queen of Sparta. Her abduction to Troy was such an affront that Greece launched more than a thousand ships to avenge the insult. After ten years of siege and brutal carnage, the Greeks devised their famous ruse. A seventh-century B.C. amphora from Mykonos (right) shows the earliest known depiction of the wooden horse that bore "death and doom for the Trojans."

DAGGER, 16TH CENTURY B.C., NATIONAL ARCHAEOLOGICAL MUSEUM, ATHENS (PRECEDING PAGE); MYKONOS ARCHAEOLOGICAL MUSEUM, MYKONOS (RIGHT)



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Wrath—sing, goddess, the accursed wrath of Achilles, son of Peleus, / which placed countless sufferings on the Achaeans, / and hurled so many strong souls of heroes to Hades, but made their bodies the spoil of dogs / and all birds; and so the plan of Zeus was accomplished. . . .

For close to 3,000 years these lines have, like a drumroll, announced the beginning of Homer's *Iliad,* one of the most enduring and influential works of art ever created. The epic poem's story line is deceptively simple, being the events of a roughly two-week period in the last year of the famous Trojan War, fought between Greeks and Trojans over Helen, the runaway wife of the king of Sparta. The explosive confrontation in the opening verses between Achilles, the greatest of all the Greek warriors gathered at Troy, and his powerful if often inept commander, Agamemnon, sets the epic in motion. In a blaze of anger Achilles withdraws from the war, with disastrous results for his Greek comrades. Only when his beloved companion Patroklos is killed by the Trojan prince Hector does Achilles return to battle, smoldering for revenge. This he achieves with the brutal death of Hector, and the poem ends with the funeral of the courageous and fated Trojan.

On another level, however, the *Iliad* explores the deepest concerns of mankind—human limitations, the relationships of individuals to their gods and their community, honor, war, mortality, and death. Its meaning is timeless. Some years ago, watching television reports from Somalia, I observed the terrible fate of a U.S. Army Ranger dragged through the streets of Mogadishu and thought how little the world had changed. No *Iliad* reader can forget Achilles' dragging the body of Hector in triumph behind his war chariot, the dead man's "dark hair falling about him."

The *Iliad* gave the Greeks of classical times—as well as us today—the pantheon of Olympian gods and goddesses. As the oldest surviving European poem, the *Iliad* was the model for such later epic poets as Virgil, Dante, Milton, and, more recently, Derek Walcott, the West Indian poet who won the Nobel Prize in 1992. Echoes of Homer abound in popular culture—Patrick O'Brian's best-selling novel *The Wine-Dark Sea* takes its title from a phrase in the *Iliad.* For these reasons, as much as for its compelling action and vivid characters, the *Iliad* remains, as we head into the 21st century, at the bedrock of human experience.

I first encountered the *Iliad* at the age of 14 and have remained in its thrall ever since. But my perceptions have changed with time and age. Once the *Iliad*'s clash of warriors struck me as glamorous and heroic. Now I read with an eye for the tragedy of lost youth. Today I would set it in an inner city, with Greeks and Trojans as two opposing gangs who, governed by private codes of desperate glory, lay waste to each other's cities and young manhood.

A classical scholar and writer, CAROLINE ALEXANDER wrote about Sir Ernest Shackleton in the November 1998 issue. JAMES L. STANFIELD, whose record of GEOGRAPHIC assignments spans 34 years, most recently photographed the two-part Roman Empire series (July and August 1997).

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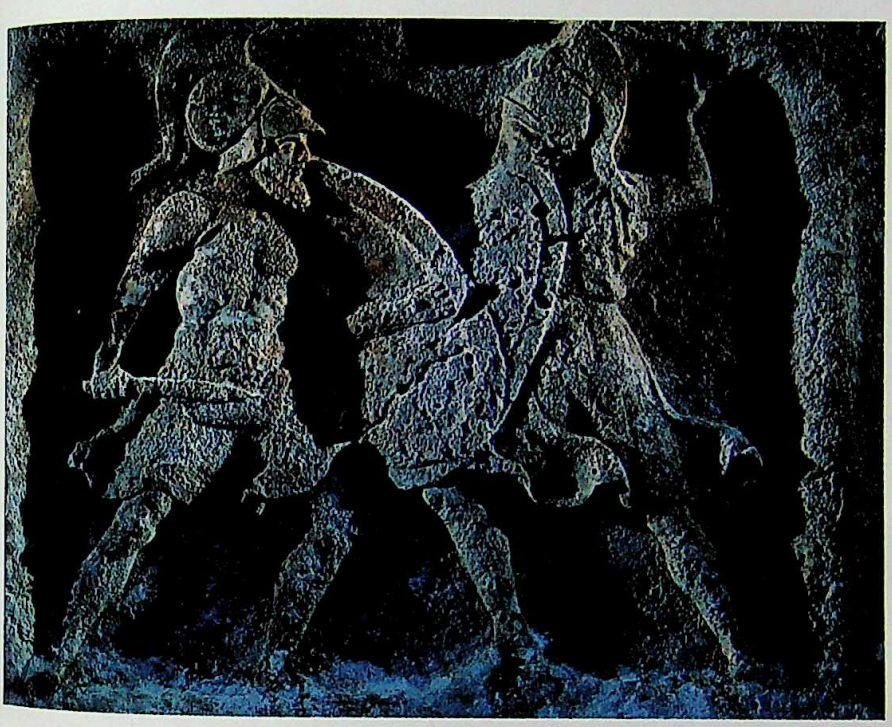
For Greeks of antiquity the *Iliad* related events from their own past; the Trojan War was taken as historical fact. Some believed they were descendants of Homer's heroes; Alexander the Great, who slept with a copy of the *Iliad,* traced his maternal ancestry back to Achilles. But the reality is far more complex. The *Iliad* is not a "true story," nor does it offer a realistic picture of life in Greece's late Bronze Age—about 1600 to 1100 B.C.

Indeed, the *Iliad* was not composed in this period, known to historians as the Mycenaean Age, but is the end result of an inspired oral poetic tradition spanning 500 years. Between the 13th century B.C., the height of the Mycenaean Age, and the age of Homer in the eighth century B.C., lie



Heroic combat caught in stone ennobles a tomb frieze found in Turkey that dates from the fourth century B.C. This scene from the Trojan siege suggests the Iliad*'s final battle, when Troy's "tall Hector of the shining helm" fought "swift-footed brilliant Achilles," hero of the Greeks. "Hector made his swoop, swinging his sharp sword, and Achilles charged," wielding a "bronze-barbed ash spear." Achilles slew Hector before the gates of Troy—and the city's hope perished.*

KUNSTHISTORISCHES MUSEUM, VIENNA

five centuries during which generations of unknown professional poets passed down the epic-in-the-making. Each added something of his own genius, and the taste of the successive audiences who kept the *Iliad* in demand must have been of the same high standard as the skill of the bards themselves. The Greeks credited the final composition of this masterpiece to a poet they called *theios Homeros*—"divine Homer"—and we, as they, know nothing more about this person than his supposed name.

Most archaeologists and scholars study the late Bronze Age for its own sake, not because they seek to shed light on the *Iliad.* "I don't *care* about Homer!" an archaeologist in Greece said to me, exasperated by the popular view that she was searching for the Trojan War. Nonetheless, sophisticated modern studies of this period continue to yield unmistakably Homeric details, proving that the *Iliad,* though not a Bronze Age work, has preserved shards of Bronze Age history. Like the archaeologist, I was not in search of the Trojan War, but I was deeply interested in all those shards of history that give the *Iliad* its rich texture: The land around Troy itself in northwestern Turkey, the giant walls of Mycenae and its fabled gold, warships of the Bronze Age, weaponry and armaments, scraps of Mycenaean, the language of the Greek Bronze Age—these relics were my quest.

In a sense the *Iliad* is a tale of two cities: Troy, or "windy Ilion," the wealthy Asiatic city commanding the Dardanelles, and "Mycenae of much

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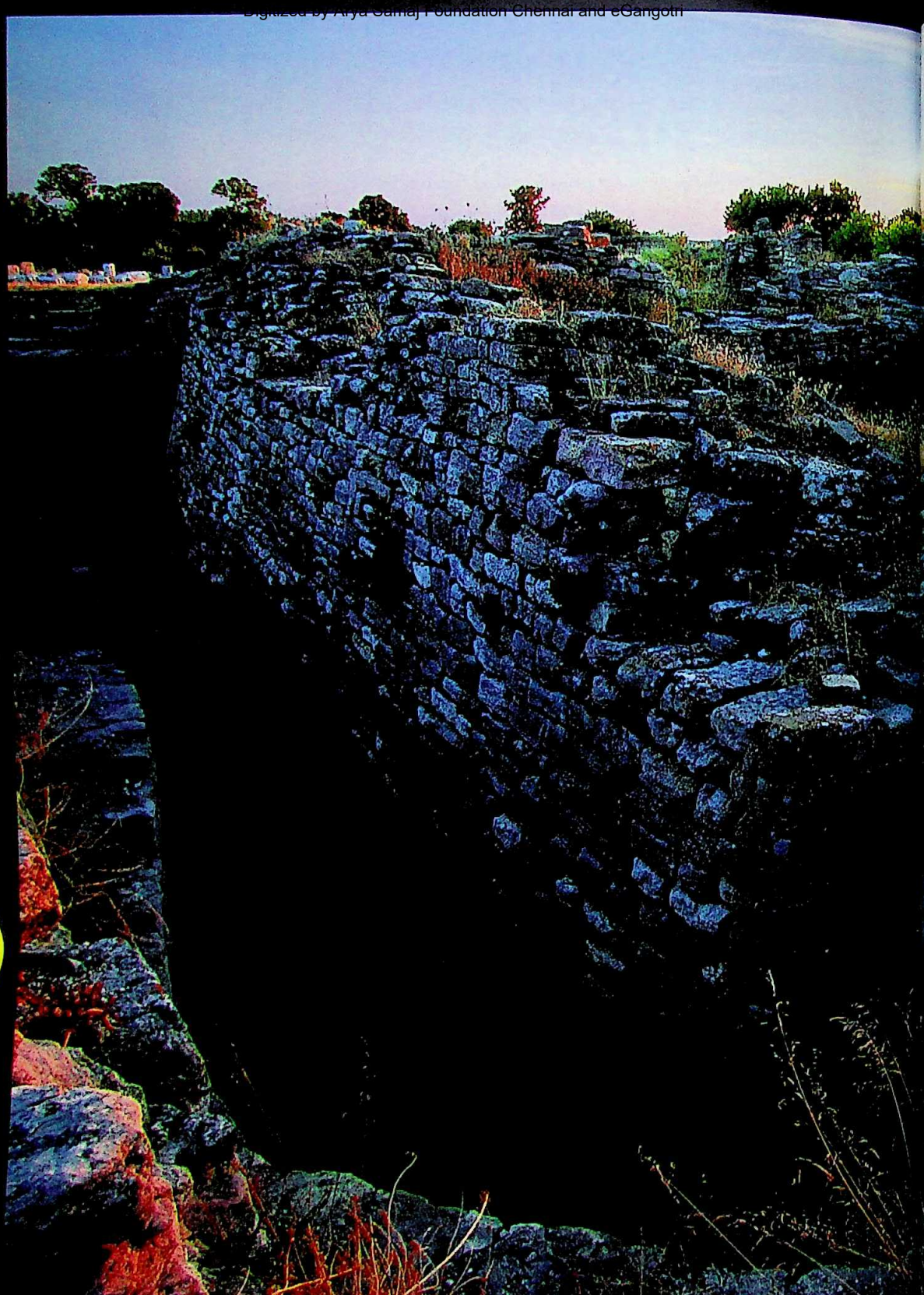

Massive walls of well-cut stone made ancient Troy impregnable—or so its people vainly hoped. Those walls have emerged from the soils of western Turkey on a hill called Hisarlik, believed to be Homer's "windy Ilion." First unearthed in the 1870s, this site bears remains

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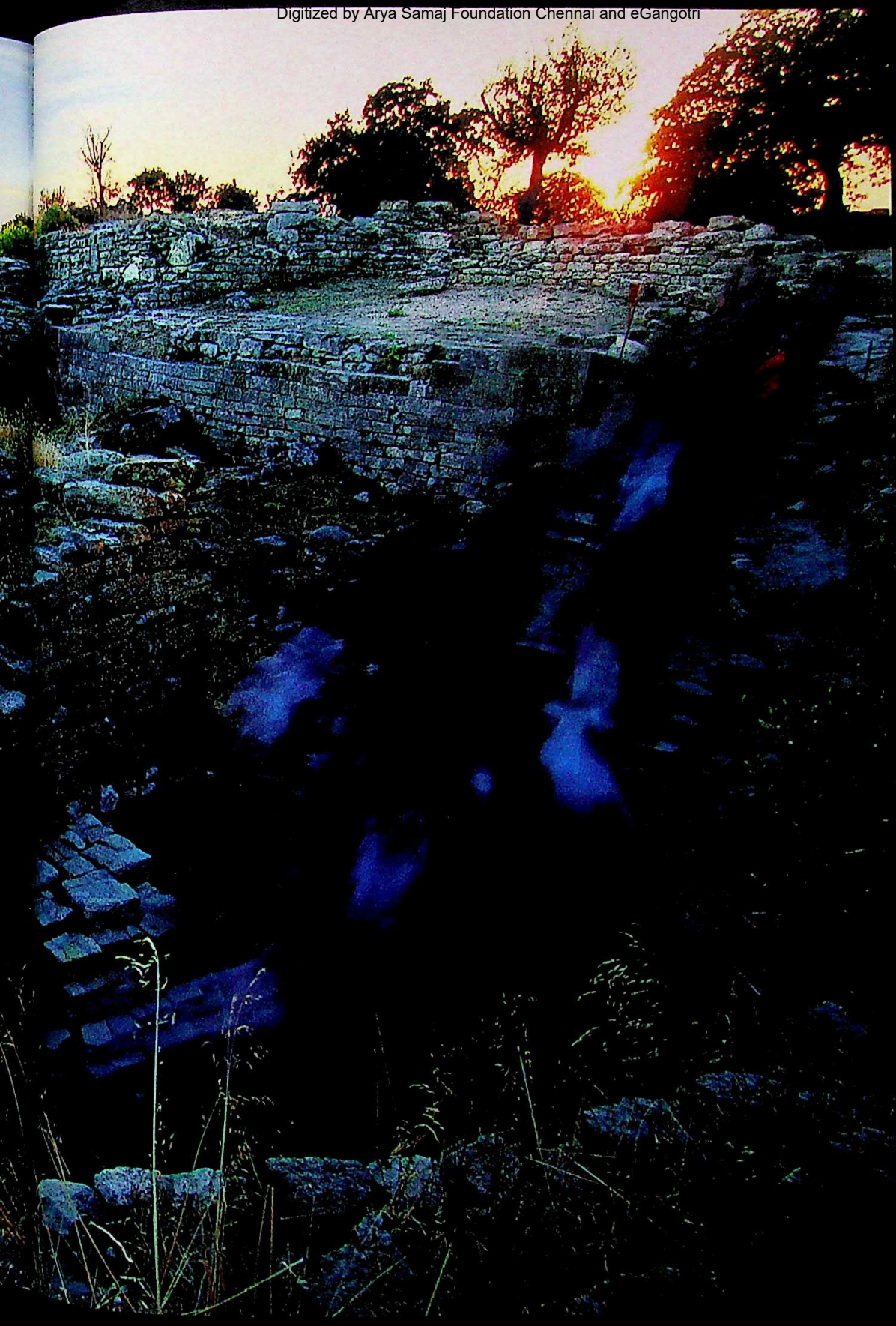

of at least nine ancient settlements spanning some 3,500 years. Troy VI (above) and VIIa straddle 1250 to 1150 B.C., the era of Homer's war. Scorch marks, skeletons, and heaps of "sling pellets" appear to be "evidence of a lost war," says archaeologist Manfred Korfmann.

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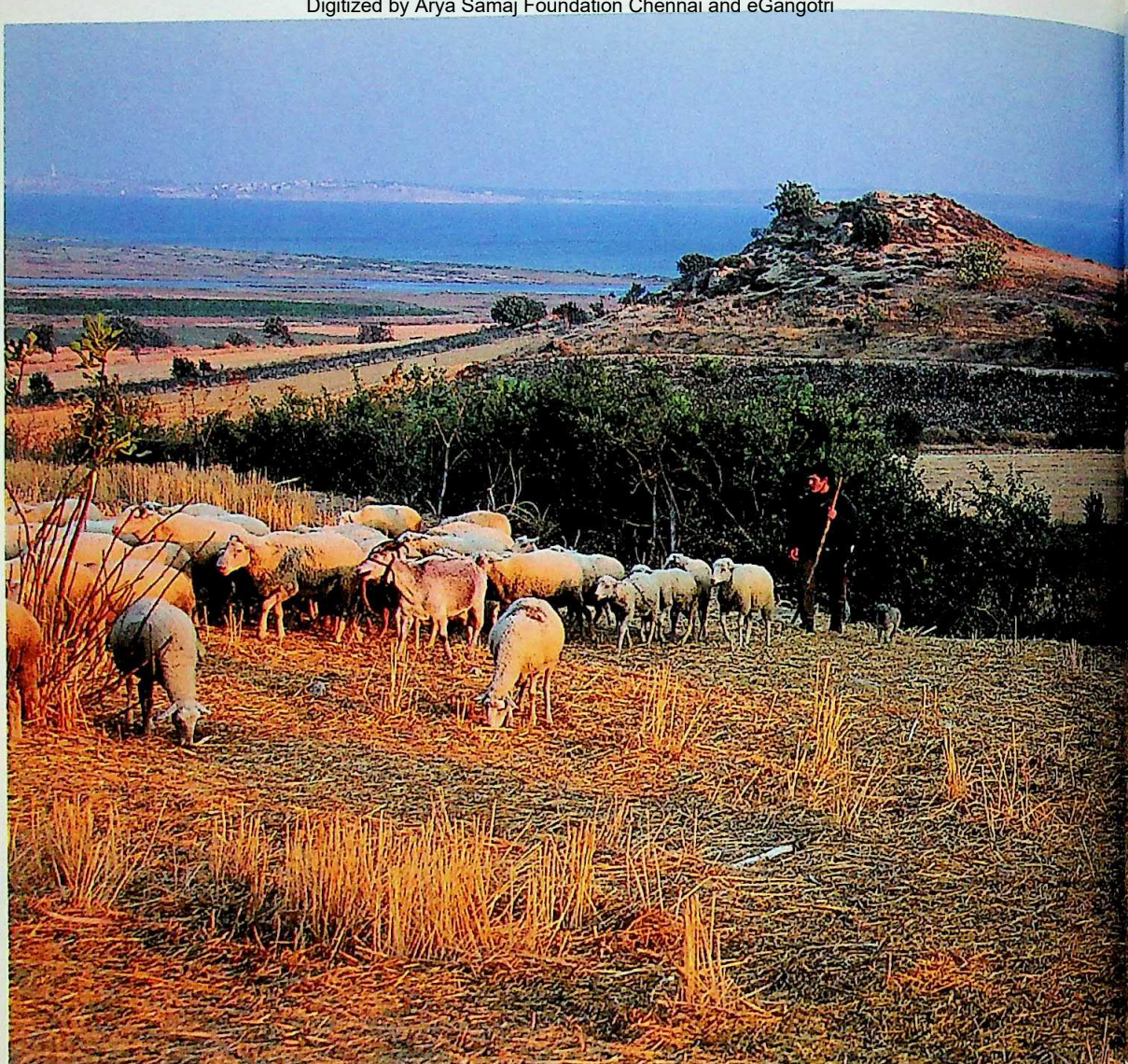

Shepherd Durmus Nayman walks a landscape of ghosts. Behind him rises the Tumulus of Ajax, one of more than 40 mounds on the plain of Troy said to honor fallen heroes of the Trojan War. Farther south on this storied plain Arife Karadeniz picks cotton with friends. Land and flocks

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were highly prized by ancient Trojans and Greeks. But such pastoral joys were denied to those engaged in the "grim work" of war. When Homer's armies clashed across this land, "the screaming and the shouts of triumph rose up together of men killing and men killed, and the ground ran blood."

gold," the city reaching the zenith of its power during the Greek invasion across the Aegean Sea to the gates of Troy. For centuries the wealth of these legendary cities was thought to exist only in the realm of imagination. But between 1870 and 1890 Heinrich Schliemann, an ambitious and ruthless businessman from Germany, put the "lost" cities on the map. Acting on the advice of a local amateur archaeologist (whom he did not bother to credit), Schliemann revealed the ruins of Troy, then found the gold of Mycenae.

The *Iliad*'s every description of Mycenae speaks of its power. And from the base of the rocky acropolis on which Homer's "strong-founded citadel" stands, I looked up to discover that these descriptions still hold true. Even in decay the great fortress remains imperious, still commanding, as it did centuries ago, the mountain-ringed plain of Argos, now a blur of purple-gold in the hazy heat. Making my way up the entrance ramp, I paused before the citadel's famous Lion Gate—posts and a lintel of colossal stone overarched by two weathered heraldic lions.

Later, at the end of the day when the tour buses had left, I stood alone on the empty acropolis, listening to the wind sigh over its massive walls as it has done for well over 3,000 years. Above me bare mountains seemed to stand as protective sentinels over the extinct city. Alert guards would have spotted approaching enemies from miles away.

As an epic, the *Iliad* is mostly interested in the fate of kings and warriors, not of the common man. And while archaeologists have uncovered traces of the small timber and mud-brick dwellings of humble people, it is the relics of Mycenae's rich and powerful that are most in evidence. The massive walls enclosed a palatial administrative complex—houses, sanctuaries, storerooms, and royal courts with colorful frescoes and sculpted stone. Wandering through the vacant citadel, past walls that had collapsed into rubble, across a floor of beaten earth that had once been decorated with painted stucco and gypsum slabs, I felt a lingering air of regal might.

In the *Iliad* the king of Mycenae, Agamemnon, is also commander in chief of the Greek forces—not on account of any special qualifications but because he has inherited Mycenae's wealth and power from his father, Atreus. The historical Mycenae dominated the Argolid, the important and wealthy region of the northeast Peloponnese that in turn controlled much Aegean trade. Schliemann and later archaeologists have located almost a dozen major Mycenaean centers in addition to Mycenae itself, as well as hundreds of settlements and tombs, all with a shared culture. Midea, Tiryns "of the huge walls," "sacred" Pylos, "thirsty" Argos, Orchomenos "rich in sheep"—the names of many of these centers were known to the *Iliad*.

The story turns mainly on a single application of Mycenae's broad power—that of leading united Greeks into war against the Trojans. Possibly no work ever written can compete with the *Iliad* in its depiction of war. With great subtlety it simultaneously evokes both the glory-seeking bravado of its young heroes and the carnage of their individual deaths.

But Agamemnon stabbed him, as he pressed forward,
straight in the face, with his sharp spear.
Nor did the helmet, bronze heavy, contain it;
but straight through it and the bone the spear passed,
and all his brains inside were spattered. . . .
So Iphidamas falling there went into the brazen slumber,
pitiable one who helping his own people, left his new bride.

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FACE-OFF OF BRONZE AGE FOES

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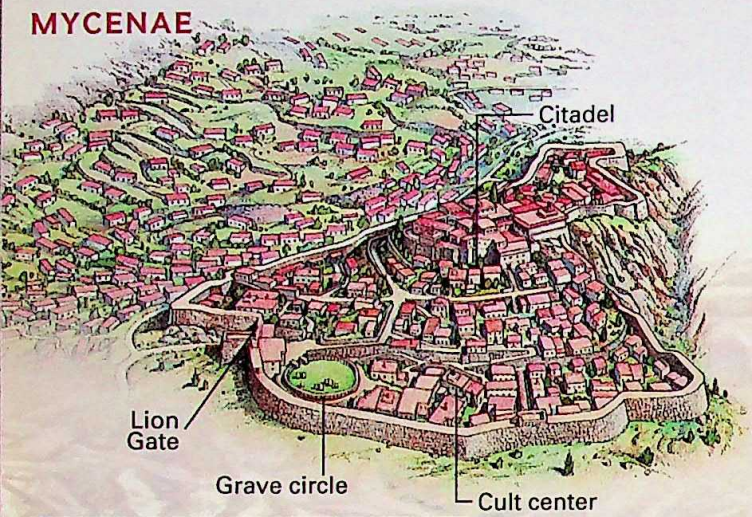

"There is much that lies between us, the shadowy mountains and the echoing sea." So spoke Greek hero Achilles, comparing his homeland to Troy. Separated by 250 miles, Troy and Mycenae were prosperous rivals. From the Peloponnese, Mycenae traded throughout the Aegean. Troy commanded the Hellespont, a key link to the Black Sea. Historians speculate that conflict over trade routes, rather than Helen's beauty, may have caused a Trojan war.

LANDSCAPE OF MYTH AND HISTORY

Time and tides have shifted the fabled terrain of Homer's Troy. Today the city's ruins lie three miles from the strait called the Dardanelles (Homer's Hellespont) across a span of marsh and alluvial plain. But in the late Bronze Age, Troy sat on the edge of a bay that opened directly onto the Hellespont, according to paleogeographers studying the region's soils.

Homer wrote that the Greeks' "hollow ships" were beached on the Hellespont. But because currents and strong northeast winds often prevented sailing up the strait, some modern scholars believe that ancient ships commonly moored at Besik Bay—five miles southwest of Troy—to wait for favorable winds. If so, this explains why the Greeks on their march to attack Troy had to cross the Scamander River, where "much ox-hide armor and helmets were tumbled in the river mud."

To end their siege, the Greeks built a towering wooden horse that concealed soldiers bristling with spears and fury. Leaving it on the beach, the Greeks pretended to sail away, then hid their ships behind Tenedos, an island five miles offshore. Trojans took in the horse, a fatal mistake that led to the sack of the city.

"You could see the flames," Trojan hero Aeneas recounts in Virgil's *Aeneid*. "All over the town you saw heartrending agony, panic, and every shape of death."

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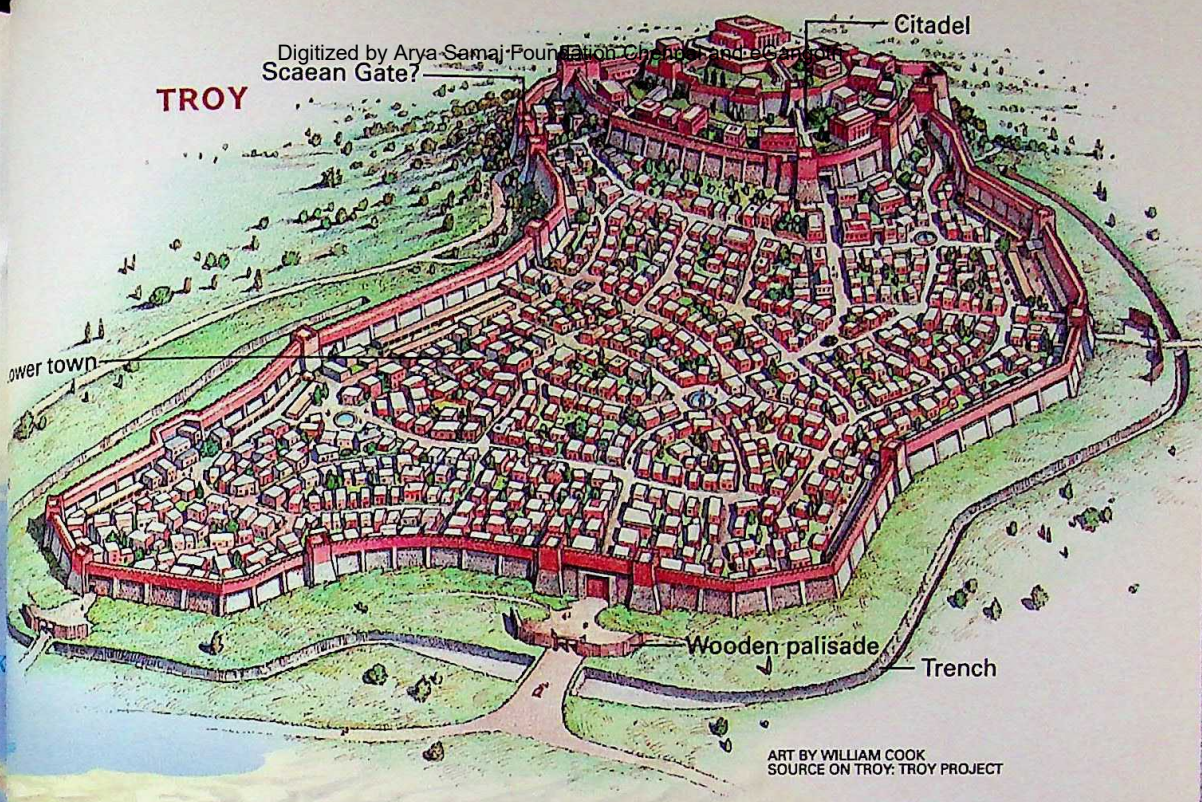

ART BY WILLIAM COOK
SOURCE ON TROY: TROY PROJECT

Mycenae. So powerful and rich was the "strong-founded citadel" that historians refer to Bronze Age Greece as the Mycenaean Age. This reconstruction, based on excavation and speculation, shows Mycenae's fortress in the late 13th century B.C., at the peak of its power. Within those 20-foot-thick cyclopean walls lived Mycenae's royalty and their minions. Visitors to the citadel would pass through the regal Lion Gate and see an ancient grave circle, resting place of earlier rulers. Charred bones on an altar in the cult center indicate animal sacrifice likely made to Zeus, Hera, and other favored gods. The palace presided over a trading empire. Excavation of workshops has revealed fine metalwork, jewelry, even carvings of hippopotamus ivory. Crafted from imported materials, such goods were exported to enrich the king's coffers.

Troy. As gatekeeper of the Hellespont, Troy may have exacted tolls from merchant ships seeking access to Asia, thus gaining wealth—and making bitter enemies. But it was well prepared for defense. In the early 1990s archaeologists discovered several wooden palisades and an extensive ten-foot-wide trench encircling a lower town. The trench, probably used to stop onrushing chariots, increased by almost ten times the known size of Troy, a thriving city of some 6,000 people. Earlier only the hilltop citadel was known, where Homer's King Priam would have ruled during the Greek siege. According to legend this "god-built bastion" had one weakness: a thin section of wall built by a mortal, near Homer's Scaean Gate. Here Hector's parents grieved as they watched their son's corpse dragged by the heels behind Achilles' chariot.

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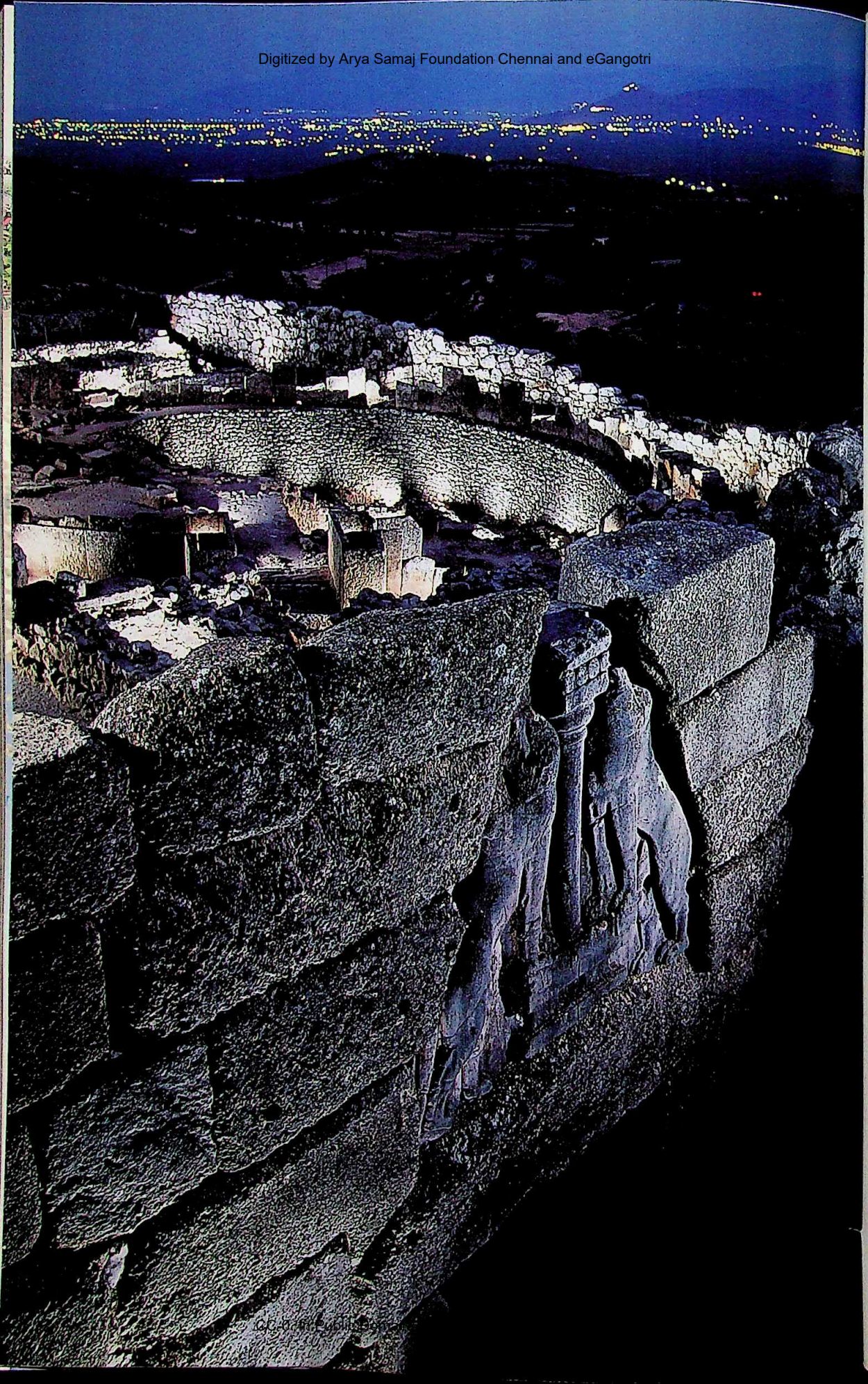

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Among the gravegoods found by Schliemann at Mycenae on display in the National Archaeological Museum in Athens is a small gold ring dating from the 16th century B.C. Its carved face shows a miniature battle scene with a man taking refuge behind a shield that covers his entire body—the kind of shield Homer describes the Greek hero Ajax carrying before him "like a wall." From later representations we know that this type of shield fell out of use some centuries later, in the 13th century B.C. The *Iliad*'s knowledge of Ajax's "wall-like" shield, therefore, must be a genuine memory preserved from early Mycenaean times.

Similarly, in one dark scene the *Iliad* describes with careful detail a helmet Odysseus wears for a night ambush—a cap with "the shining teeth

Crown of the fertile Argos plain, Mycenae retains its majesty. The grave circle inside its Lion Gate once held golden treasure, sign of the city's early wealth. Here in legend reigned Agamemnon, leader of the Greeks against Troy. Perhaps he viewed the graceful Lady of Mycenae (right), a fresco that survived the mysterious demise of the city about 1200 B.C.—a possible victim of earthquake, famine, trade collapse, or war.

of a white-tusked boar . . . close joined one after another." Archaeologists have unearthed evidence of boar's tusk helmets from several Mycenaean graves, as well as depictions of warriors wearing such helmets on ivory carvings and frescoes. Bronze shin guards, called greaves, have counterparts in the *Iliad*, as do 16th- and 15th-century B.C. swords with silver rivet caps. In this last case Homer's phrase for the "silver-studded sword"—*phasganon arguroelon*—is pure Mycenaean.

In the small museum of Lamia, I knelt before a cabinet to study a prize possession—a sherd of pottery measuring mere inches across. Scrawled like calligraphy across its surface is the crude but evocative image of two stick figures fighting on a ship. Recently discovered at Pyrgos Livanaton, on the east coast of mainland Greece, this modest fragment is one of several depicting Mycenaean warships.

"Until the discovery of these late Mycenaean sherds, Homer was thought to be describing ships of his own time in the eighth century B.C.," Fanouria Dakoronia, director of the Pyrgos Livanaton excavation, which began in 1985, said to me. "Now we know he was describing ships of the Bronze Age." The slender hull and many oars suggest a fast warship rather than the deep, heavy ships that would have been used by merchants. A leather covering may have provided weatherproofing over the prow. The ship's high prow and stern give it the appearance of a half-moon. Surely it is no coincidence that the *Iliad*'s most common adjective for ships is *koronis*—curved.

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THE MYCENAEANS LIKELY were descendants of Greek speakers who appeared on the Greek mainland around 1900 B.C. They eventually consolidated their petty chiefdoms into societies that revolved around a central palace. Heinrich Schliemann's discovery of elaborate gold burial goods showed that as early as the 16th century B.C. the Mycenaean ruling class had amassed a treasure trove of disposable wealth. Guarding both sea and hinterland, Mycenae was strategically placed to control trade in this rich region.

"You must remember, above all else the Mycenaeans were *Greeks!*" I was told by Spiros Iakovidis, the chief excavator of Mycenae and a world authority on Mycenaean culture. "Greeks and shipping have always gone together," he added with a twinkle in his eye.

Foreign markets stretching from the western Mediterranean to Egypt sought Mycenaean goods, especially pottery—painted with distinctive glossy red and black images—for domestic ware, storage jars, and ceremonial vessels. Throughout the Argolid a network of roads and bridges, carefully graded for wagons and chariots, linked the palace to other important centers, which were themselves fortified against raiders by their monumental walls.

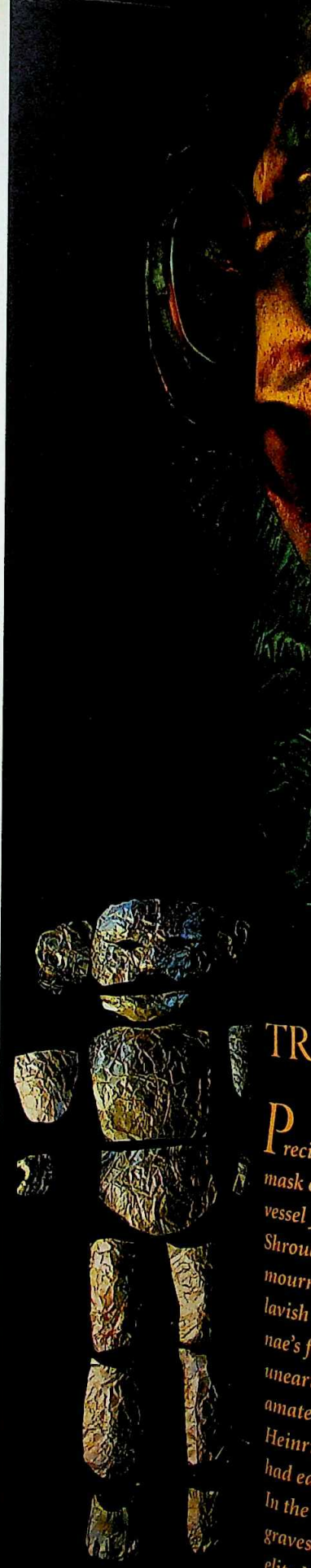
The *Iliad* is a story about war in all its devastating detail; yet it takes pains to evoke peaceful, pastoral images, as if to underscore the way of life its young warriors are missing. The clamor of the advancing Greek army is likened to the noisy swarms of "geese, cranes, and long-throated swans in the Asian meadow," its swarming numbers to insects clustering "about the stalls of the sheepfold in spring."

Yet these images are fleeting, and the *Iliad* offers little insight into how peaceable society was run or how kings ruled their cities off the battlefield. This information is found only in the archaeological record. "If you want to appreciate the range of Mycenaean culture, go to Mycenae and to Pylos," Cynthia Shelmerdine, a Bronze Age scholar from the University of Texas, Austin, told me.

While Mycenae bristles with fortifications, Pylos sits naked, without defensive walls, on a bluff looking out onto the plain below and the distant Ionian Sea. Built of soft-hued local limestone, it is a gentle site, offering the promise of civilized amenities: a terra-cotta bathtub painted with colorful patterns, for instance, and smooth benches in the waiting vestibule before a pantry that was found stacked with slender-stemmed clay drinking cups.

It was at Pylos in 1939 that Carl Blegen, an American archaeologist, made one of the most important discoveries in Bronze Age archaeology—the first of some 1,200 tablets inscribed with a mysterious script dubbed Linear B. The tablets had been preserved by accident, baked by the flames of a fire that destroyed the palace around 1200 B.C. For years the language of Linear B baffled scholars and remained undeciphered. Then in 1952 Michael Ventris, a brilliant young British architect, announced in a BBC radio interview that he had cracked the code of the tablets, and that their language was Greek—a clumsy, antiquated Greek, to be sure, but nonetheless indubitably Greek. Before this, no one had known what language the Mycenaeans spoke.

Expectations ran high as to what the tablets would reveal. Scraps of epic poetry, perhaps, written in the *Iliad*'s distinctive hexameter? Such hopes were dashed with the revelation that the tablets contained inventory lists: tallied measures of olives, wine, chariot wheels, tripods, sheep, horses,



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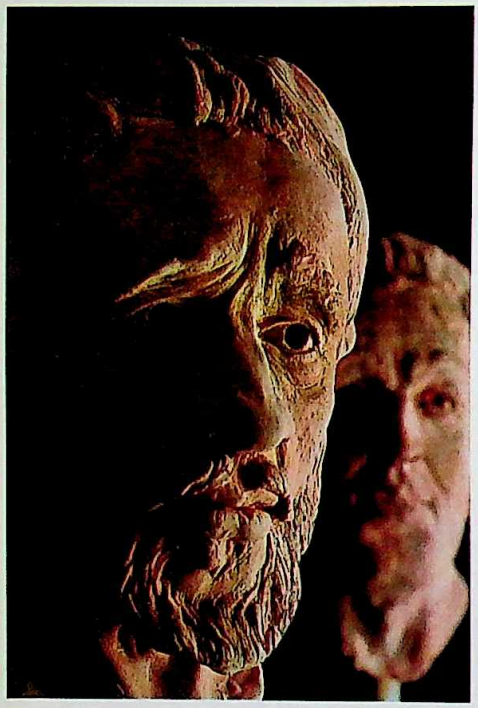
ALL FROM NATIONAL ARCHAEOLOGICAL MUSEUM

TREASURES OF MYCENAE "RICH IN GOLD"

Precious metal for a mask of death. Lion's-head vessel for sweetened wine. Shroud of gold for a child mourned. Such was the lavish inventory of Mycenae's famous grave circle, unearthed in 1876 by amateur archaeologist Heinrich Schliemann, who had earlier excavated Troy. In the circle six shaft graves bore remains of 19 elite Mycenaeans of the early 16th century B.C. Unaware that the graves predated the Trojan War by at least 300 years, Schliemann mistakenly claimed he had found "wide-ruling Agamemnon" (above). A few scholars question this mask's provenance, but none dispute that the other buried riches of silver, gold, and ivory prove Mycenae a leader of Bronze Age Greece.

Digitized by Arya Samaj Foundation Chennai and eGangotri
oxen (with breed names like Dusky and Dappled), wheat, barley, spices, and plots of land tilled and taxes collected.

"It is nonetheless remarkable how much these lists *can* tell us," John Chadwick of Cambridge University pointed out. I visited Chadwick, a leading scholar of Mycenaean history and a close colleague of Michael Ventris, shortly before his death in the fall of 1998.



Furrowed brows signal physical pain for Mycenae's early leaders, whose bones bore signs of arthritis. Their skulls, from about 1600 B.C., were used for facial reconstruction by scientists at the University of Manchester in England. Later Mycenaeans were buried in vaulted tholoi, *or beehive tombs, such as the Treasury of Atreus (opposite). Dating from 1250 B.C., it was looted in antiquity.*

MANCHESTER MUSEUM, UNIVERSITY OF MANCHESTER

"The tablets represent a kind of freeze-frame of the palace's state of affairs in its last year—perhaps even its last months," Chadwick said. Tablets found at other sites confirmed that the Linear B inventories were characteristic of the complicated systems of trade, industry, and taxation of the Mycenaean palace economies. Each of Pylos's subject regions paid taxes to the palace in the form of such goods as ox hides, fattened hogs, and textiles of wool and linen. Lists of bronze workers and vats of scented oil attest to bronze and perfume industries.

EXCAVATIONS at Pylos also shed light on another cornerstone of peaceable life—routine religious practice. Scratched on the Linear B tablets are the names of deities familiar from the *Iliad:* Zeus, Hera, Athena, Poseidon, Hermes, and possibly Apollo, under his Homeric name Paieon. But the tablets also cite unknown deities, and names we would expect to find are missing, such as the goddess of love and pleasure, "sweetly laughing Aphrodite."

Offerings of animal sacrifice and the pouring of choice liquids, called libations, are the *Iliad*'s standard form of worship—a direct, no-nonsense way of inducing the higher powers to heed one's prayers. The Pylos tablets mention tributes of oxen, goats, sheep, pigs, wine, perfumed oil, wheat—these were the gifts the Mycenaeans gave their gods.

What the Mycenaeans believed happens after death, we do not know. Excavators have discovered a hundred *tholoi,* or dome-shaped tombs, and countless chamber tombs cut into hillsides—usually cheaper vaults for the less wealthy. Tombs were often shared by family members, the older dead moved aside to make way for the new. Intimate personal objects accompany the bodies—toys, babies' bottles, combs, jewelry, weapons, professional tools—perhaps sentimental tokens.

One of these grave objects provides a tantalizing correspondence between Mycenaean archaeology and Homeric text. In the National Archaeological Museum in Athens I gazed at a delicate golden balance scale of a kind archaeologists have found in Mycenaean burials. For me it conjured the unforgettable scene preceding Hector's death at the hands of Achilles:

> *Then Zeus the Father balanced his golden scales,*
> *and in them he placed two fated portions of prostrating death*
> *—that of Achilles, and that of Hector, breaker of horses—*
> *and taking them in the middle, he balanced them; and Hector's death day sank.*

The *Iliad* recognizes that war destroys more than individual warriors. Its concern is for the collective fate of cities, as well as the lives of noncombatants. Contained in the lists of the Pylos tablets, along with other

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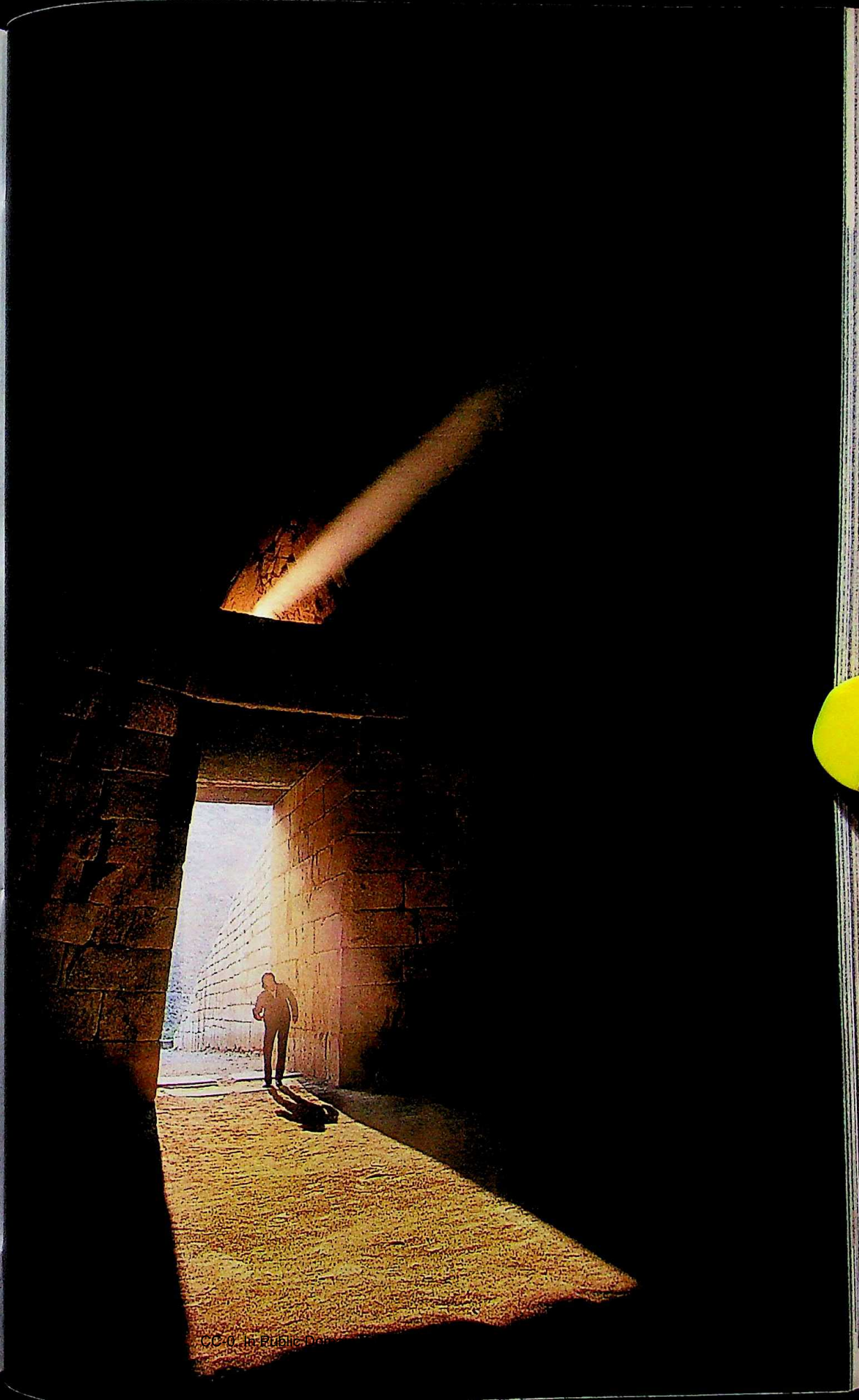
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commodities, are groups of slave women, classified according to the tasks they perform—corn grinders, spinners, pourers of baths—or the places from which they were captured—"women of Knidos," "women of Miletos," "women of Asia." The lists evoke a famous scene in the *Iliad* where Hector addresses his tearful wife, Andromache, telling her that his own fate weighs less heavily on him than

> *. . . the painful thought of you, when some bronze-armored Achaean leads you off weeping, robbing your day of freedom; and in Argos you weave at the loom of another.*

THE GREEK EPIC is remarkably sympathetic not just to Hector and Andromache but to all the enemy Trojans. Few action adventure stories—for that is what the *Iliad* is—would dare blur the line between good and bad characters, hero and enemy. But the *Iliad* is concerned ultimately with sweeping truths—the universal pity of death, the terror of mortality—not accidents of nationality. Thus the epic presents both Achilles and Hector as sympathetic men with much to live for, then inexorably moves them toward the showdown that will cost both their lives. It is impossible to read the Greek *Iliad* and not care about the city of the Trojans.

Eyes on the present, Havva Guler of Kumburun, a village near the Trojan plain, says she's unfamiliar with the tale of Troy's fall. For Trojan women that fall meant certain slavery and heartbreak. The Greek playwright Euripides penned their lament: "The multitudes of our children stand clinging to the gates. . . . And one girl weeps: 'O Mother, the Achaeans take me away lonely from your eyes to the black ship.'"

Today remains of Troy's walls still stand where Homer described the city, near the Dardanelles, overlooking a plain crossed by two rivers lined with willows, the *Iliad*'s Simois and Scamander. Once at the fallen city I slowly followed the subtle curve of the high sloping walls of Troy VI, one of two excavated levels that overlap the critical "Homeric" 13th-century B.C. level. Fortunately I had timed my visit for late evening, when the setting sun made the walls glow gold and set fire to the Dardanelles, called by Homer the Hellespont, "where fish swarm."

Heinrich Schliemann's excavation of Troy was, by modern standards, impatient and brutal. Sinking deep trenches to bedrock, where he was sure Homer's Ilion must lie, he destroyed intervening layers of history. Today an international team of archaeologists under the direction of Manfred Korfmann of Germany's Tübingen University in partnership with the University of Cincinnati is reexcavating the entire site. The object of their scrutiny is not just Hisarlik, the hill on which the ruins of Troy stand, but also the coastal area and surrounding plain, where according to the *Iliad* the Greeks beached their curved ships and the war was waged. Troy's many levels—nine in all—range from 3000 B.C. to the Roman city of New Ilium in the early sixth century A.D.

According to one version of Greek tradition the Trojans were the descendants of the hero Teucer, who came from Crete, seeking a place to settle. The historical Trojans, however, may have been Luvians, an Anatolian people who became vassals of the Hittites. Animal bones show that the Trojans kept sheep, cattle, pigs, and horses, while carbonized seeds indicate that they cultivated barley in marshy valleys. The city had a thriving wool industry and traded throughout Central Asia, receiving horses from the steppes beyond the Black Sea, tin from Afghanistan. Whether or not Troy ever went to war with Mycenae, there certainly was trading contact between the two peoples. Mycenaean pottery at Troy dates as far back as 1500 B.C.

In the past, visitors to Troy have been struck by the smallness of the site, wondering how so insignificant a place could have entered legend.

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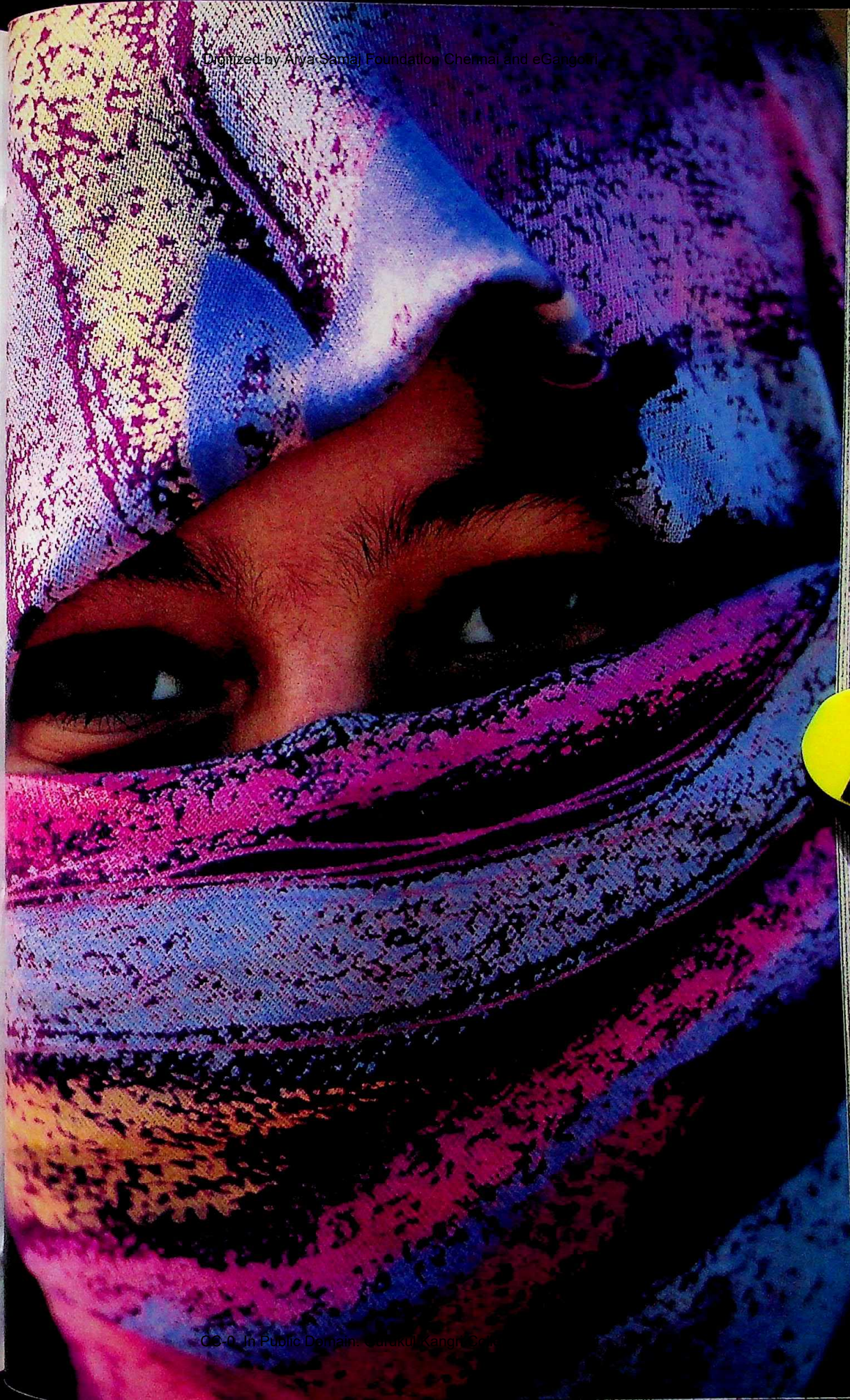

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But directing me through high grass and cotton fields well beyond Schliemann's citadel, Korfmann pointed out a line of trenches that reveal one of his team's most exciting discoveries—the outer defenses of an entire lower town below the citadel. Here Korfmann's team located evidence of an encircling trench—some ten feet wide and eight feet deep—1,300 feet beyond the citadel walls. Increasing the known area of Troy VI by as much as 50 acres, the reconfigured city is almost ten times as large as Schliemann's citadel, containing a population of at least 6,000.

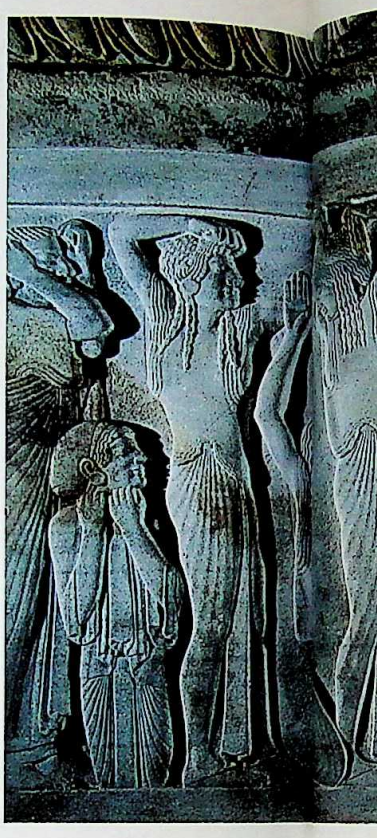
"Hittite documents refer to Taruisa," Korfmann told me. Taruisa has been identified by scholars with Troy. "*Tara* may be Luvian for 'wooden' —the city's name is perhaps a reference to the wooden houses of the lower town, which would have been conspicuous."

Yet the *Iliad* refers only to Troy's "well built walls" of stone, such as Schliemann found on the citadel itself. These walls—and the damage done to them—have given archaeologists the most reliable key to the fate of the city. Cracks and fire marks indicate that an earthquake destroyed the first Homeric candidate, Troy VI, around 1250 B.C. Soon afterward the same people who fled the earthquake returned to repair their city, creating a second settlement, Troy VIIa. The remains of small, cramped houses indicate that a larger population than before crowded inside the protective walls, while buried storage jars suggest to some scholars preparations for a siege. Flame-damaged walls indicate that about 70 years later a fierce fire destroyed this settlement. Was this the Troy, weakened by earthquake, that the invading Greeks finally sacked? Or had the Greeks attacked but not destroyed Troy VI in the wake of a natural disaster? Or was the fall of Troy entirely unrelated to the Homeric legend?

"We are no longer interested in proving whether the Trojan War took place or not," Korfmann told me sternly. Nonetheless, he has a compelling theory: "Windy" is how the *Iliad* describes Troy, and from antiquity to the present day a prevailing northeasterly wind has blown into the teeth of the city, down the Dardanelles. Bronze Age ships did not have deep keels, and it was difficult for them to sail against the wind. Merchant vessels seeking the valuable trade north of the Dardanelles therefore had to beach at Troy—where they would have been sitting ducks for Trojan tribute collectors—and wait for a favorable breeze.

"We know from later texts that occupants of the region exacted tolls from incoming vessels," said Korfmann. In a nearby sandy cove called Besik Bay, his team discovered burials reflecting different cultural influences. Here the hapless crews of stranded ships could have ended their wait for a following wind. At a crossroads of trade between East and West, Europe and Asia, Troy may have grown rich from tribute—and long been a thorn in the side of merchant entrepreneurs like the Mycenaeans.

"It is possible that Troy experienced several commercial skirmishes, if not one Trojan war," said Korfmann.



Sacrificial revenge adorns a sixth-century B.C. stone sarcophagus from Turkey—and attests to the lure of Trojan themes for ancient artists. Here Achilles' son, Neoptolemos, stabs Polyxena, daughter of the king of Troy. Virgil described Polyxena as the "maiden daughter of Priam . . . who never knew captivity or the bed of a conqueror."

ÇANAKKALE ARCHAEOLOGICAL MUSEUM, ÇANAKKALE, TURKEY

WHETHER OR NOT THEY PLAYED any role in Troy's destruction, the Mycenaeans did not long survive the city's fall. Why the apparently thriving Mycenaean civilization collapsed remains one of the most baffling questions of Bronze Age history. Pylos, Mycenae, Tiryns, Midea—nearly all the great palaces fell sometime around 1200 B.C. Some scholars have sought the cause in natural disasters, citing an earthquake such as destroyed Troy VI or even climatic change. Another theory

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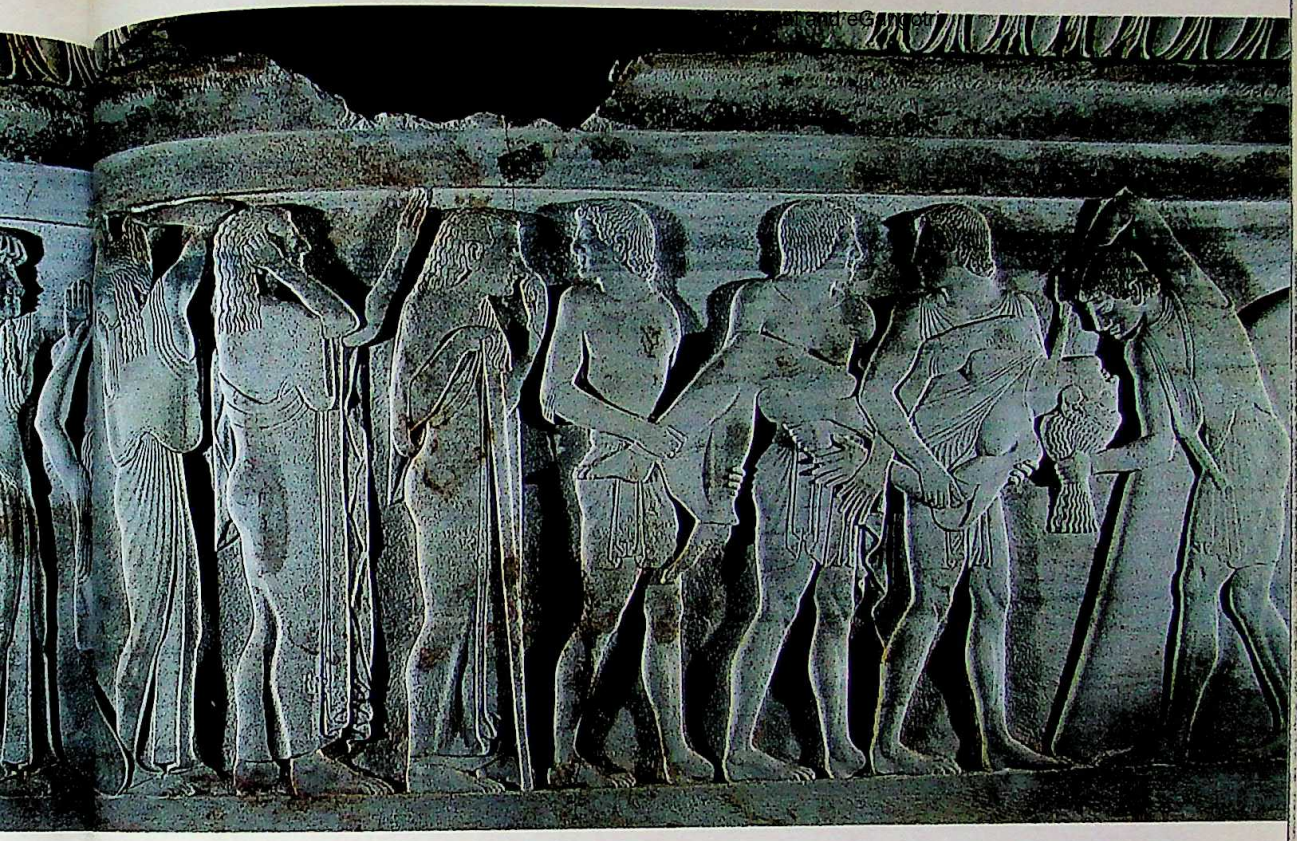

has it that the Mycenaean economy, highly centralized and bureaucratic, became overextended and collapsed under its own weight. The downfall of Mycenaean palaces occurs at about the same time as the fall of numerous cities throughout the Aegean and eastern Mediterranean, and although there is no archaeological evidence of foreign invasion, a revolutionary change in fighting tactics may have given barbarian raiders a new advantage. Most scholars suggest there was a protracted decline, a slow trickling away of the population.

Professor Iakovidis, Mycenae's chief excavator, told me that trade was the key to the city's great wealth. And according to him it was likewise the cause of its decline. When the Hittite Empire fell and the great cities of the East were sacked, the intricate network of trade that defined Aegean economics for centuries was unraveled. Deprived of their revenues, the Mycenaean palaces were left with no outlet to do what they did best and no means—or reason—to keep their bureaucracy afloat.

"The Mycenaean world ended, if I may say, 'not with a bang but a whimper,'" said Professor Iakovidis.

The collapse of the Mycenaean world marked the beginning of several centuries traditionally known as the dark age of Greece, a period of shrinking populations, poverty, and cultural decline. Gone were the rich palaces with their colorful frescoes and imported luxuries. All the sophisticated arts of palace civilization were lost—monumental architecture, painting, metalwork, literacy. Yet it is this period of apparent cultural vacuum that transmitted two of the world's literary masterworks: the *Iliad* and the *Odyssey*. And while the *Iliad* bears evidence of its Mycenaean roots, it was the unknown poets of the dark age, centuries removed from the events they described, who fostered the great epic.

It is not difficult to imagine wayfarers from the fallen Mycenaean towns

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Paper shields and exuberant smiles are the weapons of mock war between young Trojans and Greeks reenacting the final defeat of Troy at the Moseley Primary School in Birmingham, England. "I was a Trojan," says Lara Owen, center. "The Greeks were my enemies and

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I wanted to beat them, but I knew we would die in the end." She knew because Homer's story has never died; it was taught in antiquity and expanded through the works of later literary masters. Yet few wrote with the force of Homer about the "inhuman clamor" of war.

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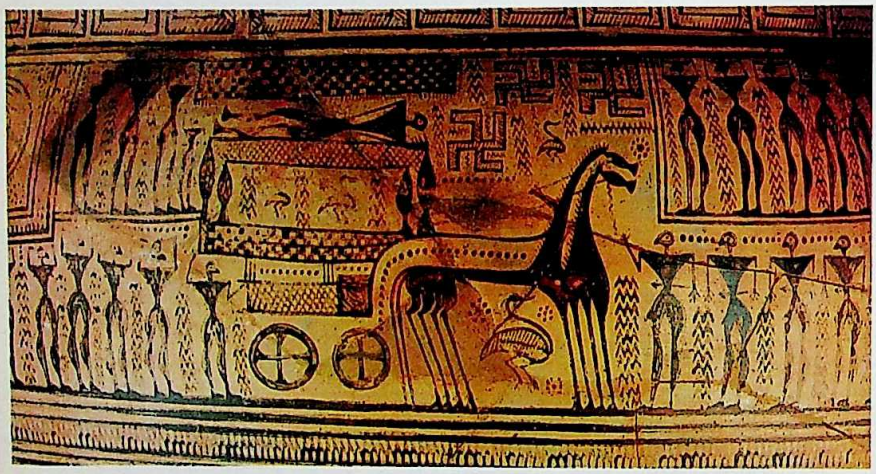
carrying their storytelling traditions with them during the 11th century B.C. As the generations passed, successive storytellers may have transformed a minor trade skirmish in Anatolia—or elsewhere—into an epic clash between Asiatic Troy and a unified force of Greek-speaking warriors, much as Britons wistfully re-created the history of their clashes with invading Anglo-Saxons into the legends of King Arthur.

The close of the eighth century B.C. revealed an entirely new human landscape. Everywhere populations had rebounded. Isolated settlements had given way to small city-states. Perhaps the characterization of the independent-minded hero Achilles and the *Iliad*'s interest in different types of leadership reflect associated political change. Trade had revived



and overseas colonization flourished.* Above all, the new era revealed the epic poems attributed to Homer.

The *Iliad* does not end with the victory of Achilles over Hector, the loving husband and good citizen who was his enemy. Overreaching this transitory triumph, the epic adheres to its higher purpose, and Achilles is last seen weeping for the death of his companion, for his aged father who will soon die, for Priam, the father of his enemy, for himself—and the reader feels his own mortality weigh more heavily.

Across the Dardanelles from Troy is Gallipoli, the battlefield that claimed the lives of tens of thousands of young men in World War I. The same strong wind that scourges Troy blows here too, and on occasion I thought I would be swept into the sea. From the memorial monument on the Gallipoli headland one can see the plain of Troy. Inland the war cemeteries contain neat rows of graves of the fallen. Reading their tombstones, I found myself thinking, yet once again, how little the world has changed. Repeatedly throughout the *Iliad* the heroes speak of their desire for glory, their hope that their names will be remembered by generations to come.

Let me at least not die without a struggle, inglorious,
but having done some big thing first, for men to come to know of.

So said Hector, bracing himself for his final battle with Achilles.

"Their name liveth for evermore," read gravestones at Gallipoli. "Their glory shall not be blotted out." □

*See "When the Greeks Went West," NATIONAL GEOGRAPHIC, November 1994.

Is the spirit of ancient Greece alive or dead? Reflect online at *www.nationalgeographic.com/ngm/9912.*

Primitive power imbues the Centaur of Lefkandi, crafted during Greece's dark age—the period following the collapse of Mycenaean centers about 1200 to 1100 B.C. During that time fine arts and writing ceased. Through pottery historians trace the recovery of Greece in the eighth century B.C. Art on a funeral vessel (left) shows the intricate geometric patterns and stylized figures that signaled a return of wealth and artistic innovation. Perhaps the greatest artistic achievements of that era were Homer's Iliad *and* Odyssey*—timeless epics of early Greece.*

ERETRIA ARCHAEOLOGICAL MUSEUM, ERETRIA, GREECE (RIGHT); NATIONAL ARCHAEOLOGICAL MUSEUM

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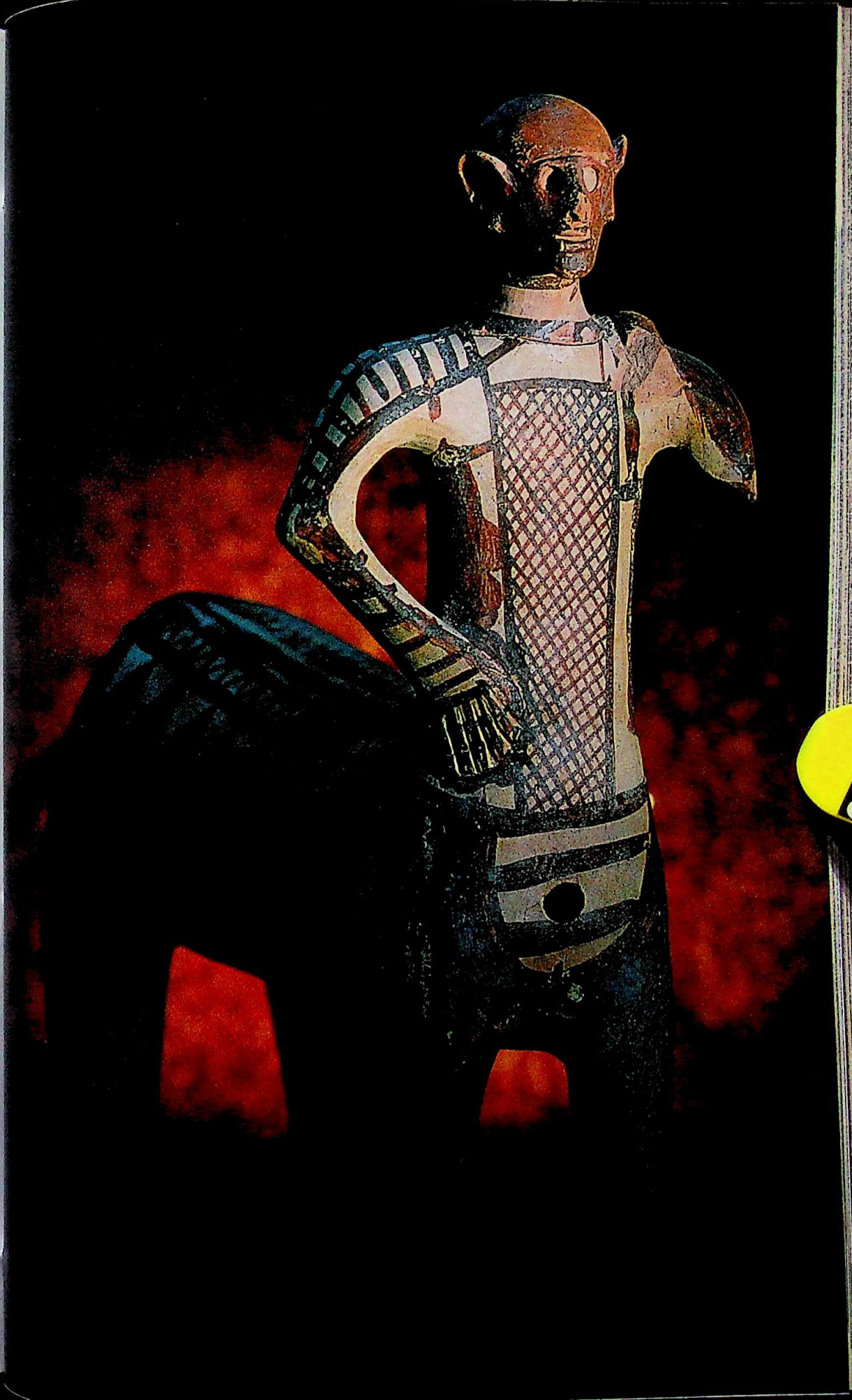

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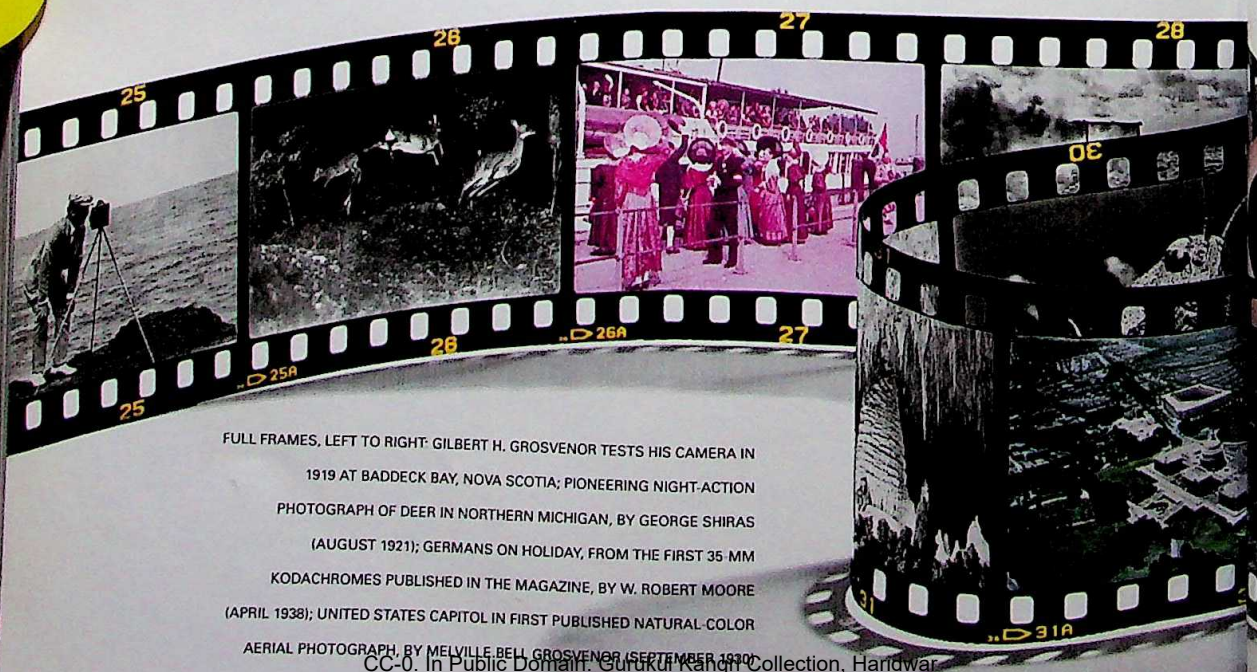
GEOGRAPHIC

Expanding Human Vision

Light is life, in a very real sense, and this is what makes photography so vital. More than a century ago, when we learned to fix light's splendid variations on glass plates, celluloid, and paper pages, we thought that we had captured some elusive moments of life itself.

Since the 1890s National Geographic photographers have captured light where members could not go themselves: where it was too far, too deep, too cold, too dangerous. To mountaintops and Arctic shores, ocean bottoms and outer space. To places beyond human sight, freezing the flicker of a hummingbird's wings, penetrating solid objects, distant galaxies, and the mysteries of our own bodies.

In the 1910s the Society hired wizards of optics and chemistry like Charles Martin and Edwin "Buddy" Wisherd, technical men who not only took pictures but also established at the Geographic one of the nation's finest color laboratories. In the 1930s came Renaissance men like Luis Marden, who combined writing, photography, and intellectual vigor. Marden pioneered the use of Kodachrome, a fast, nearly grainless color film that enabled Geographic photography to soar. He also worked closely with Jacques-Yves Cousteau in the 1950s to develop



FULL FRAMES, LEFT TO RIGHT: GILBERT H. GROSVENOR TESTS HIS CAMERA IN 1919 AT BADDECK BAY, NOVA SCOTIA; PIONEERING NIGHT-ACTION PHOTOGRAPH OF DEER IN NORTHERN MICHIGAN, BY GEORGE SHIRAS (AUGUST 1921); GERMANS ON HOLIDAY, FROM THE FIRST 35-MM KODACHROMES PUBLISHED IN THE MAGAZINE, BY W. ROBERT MOORE (APRIL 1938); UNITED STATES CAPITOL IN FIRST PUBLISHED NATURAL-COLOR AERIAL PHOTOGRAPH, BY MELVILLE BELL GROSVENOR (SEPTEMBER 1930)

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CENTURY

waterproof camera housings that, along with scuba gear, gave underwater photographers the freedom of fish.

Staff photographer Emory Kristof took us much deeper starting in the 1970s, pushing the Society to invest in lighting and remotely operated vehicles. He photographed new life-forms swirling around hydrothermal vents and, diving with explorer Robert Ballard in 1985, made the first photographs of the sunken *Titanic*, two and a half miles down.

Stopping motion was the specialty of Harold Edgerton, a professor at MIT, who developed a high-speed electronic flash in 1931 and perfected it with the help of Society grants. Using xenon-gas-filled quartz tubes, Edgerton illuminated what was invisible to the naked eye.

These innovations were usually joint efforts. Field photographers were artists at heart and relied on technicians like Al Chandler, a self-taught design engineer. Chandler, who once played guitar for country singer Patsy Cline, built ingenious electronic camera systems and underwater "suns" of light in our photoengineering division. Its credo: You dream it; we build it. New dreams await in the new century. We will follow life and light where they lead us.

Bill Allen

"The world and all that is in it is our theme," proclaimed the Society's second president, inventor Alexander Graham Bell. A century-long commitment to exploring that grand theme through the universal language of photography has carried readers from the deep ocean to the stars on a flood tide of artistic and technical innovation.

BULLET-PIERCED APPLE, BY STROBE INVENTOR HAROLD EDGERTON (OCTOBER 1987); REMOTELY TRIGGERED EXPOSURE OF JET LANDING, BY BRUCE DALE (AUGUST 1977); COLORIZED 3-D IMAGE BASED ON CT SCANS MADE AT MEMORIAL SLOAN-KETTERING CANCER CENTER, NEW YORK, BY HOWARD SOCHUREK (JANUARY 1987)

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Photographer Emory Kristof takes a backyard dip with two ROVs—remotely operated vehicles (January 1998). They let him send lights and cameras into waters too deep or too treacherous for human divers. The ROVs have been rebuilt and refined many times in the Society's own wizards'

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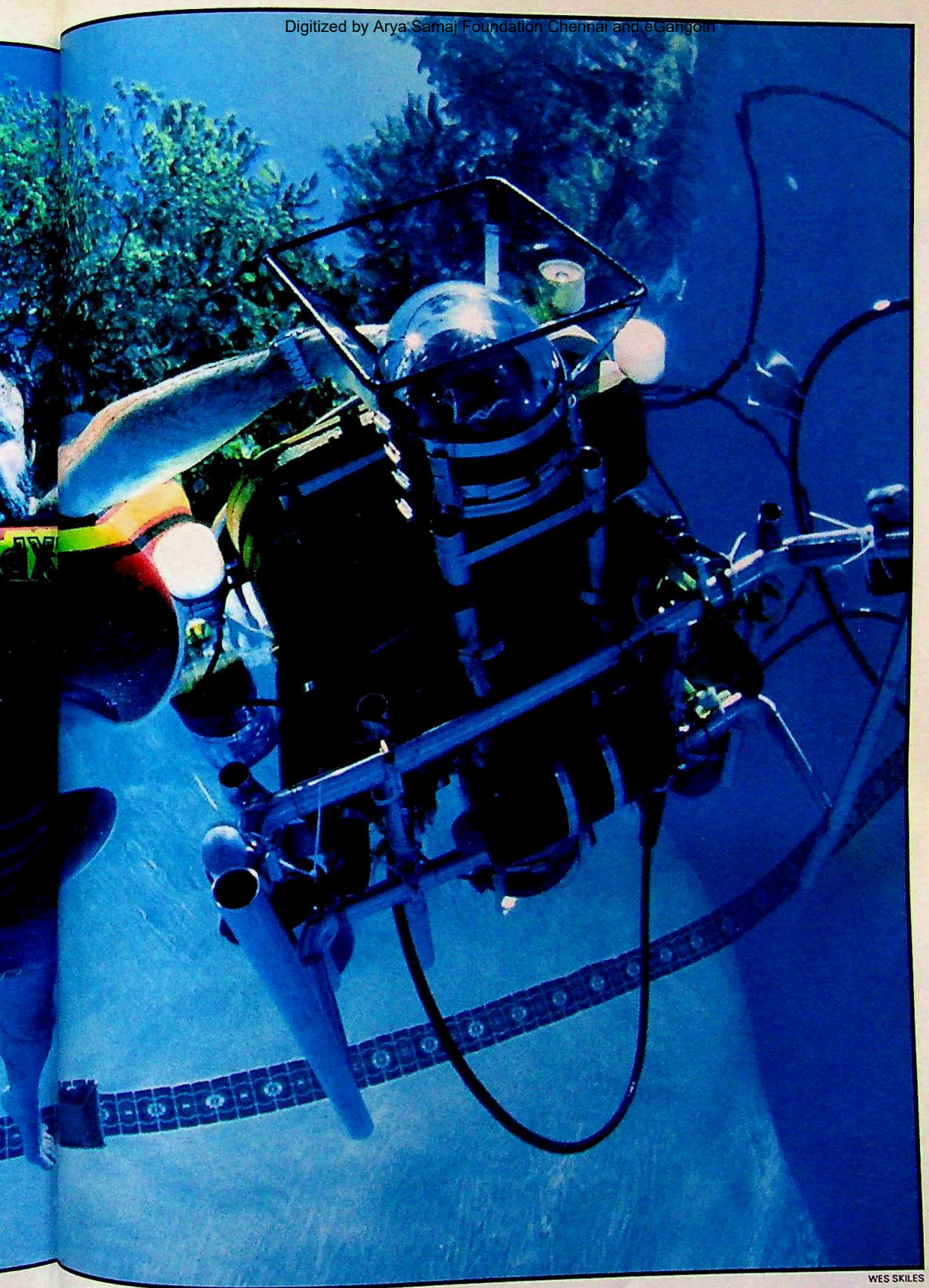

WES SKILES

workshop, Photo Engineering. "Emory pushed the Geographic to invest in new technologies, new vision—like Luis Marden did with 35-mm cameras and Kodachrome film in the '30s," says special projects editor Bill Douthitt. "The status quo has never been good enough."

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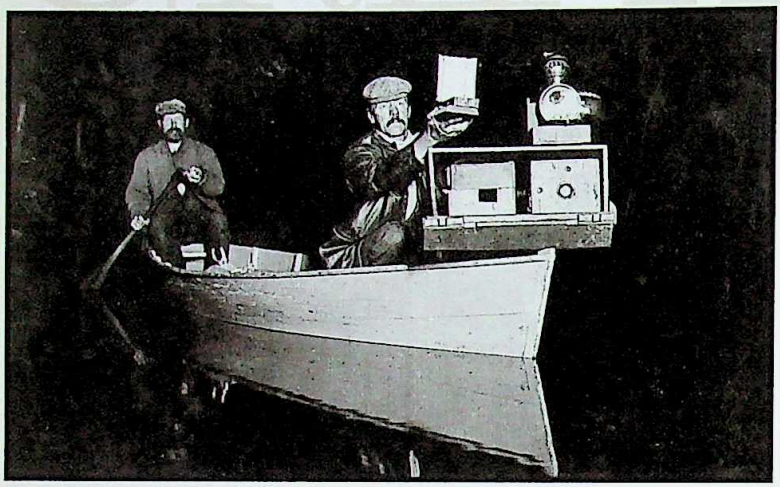
"The simple pressing of a button



Geographic nature photography took off in 1906, when Editor Gilbert H. Grosvenor published 32 flashlit wildlife images by George Shiras (above) in a single issue. Two Society board members resigned, protesting that "wandering off into nature is not geography." Undaunted, Grosvenor printed another Shiras portfolio (below) in 1921. For an April 1975 story on Tanzania, Emory Kristof replaced his camera's shutter with two strips of black tape. Exposing film through the resulting slit, he made pictures that drew viewers *into* the frame—to gallop alongside the zebra as the land blurred past.

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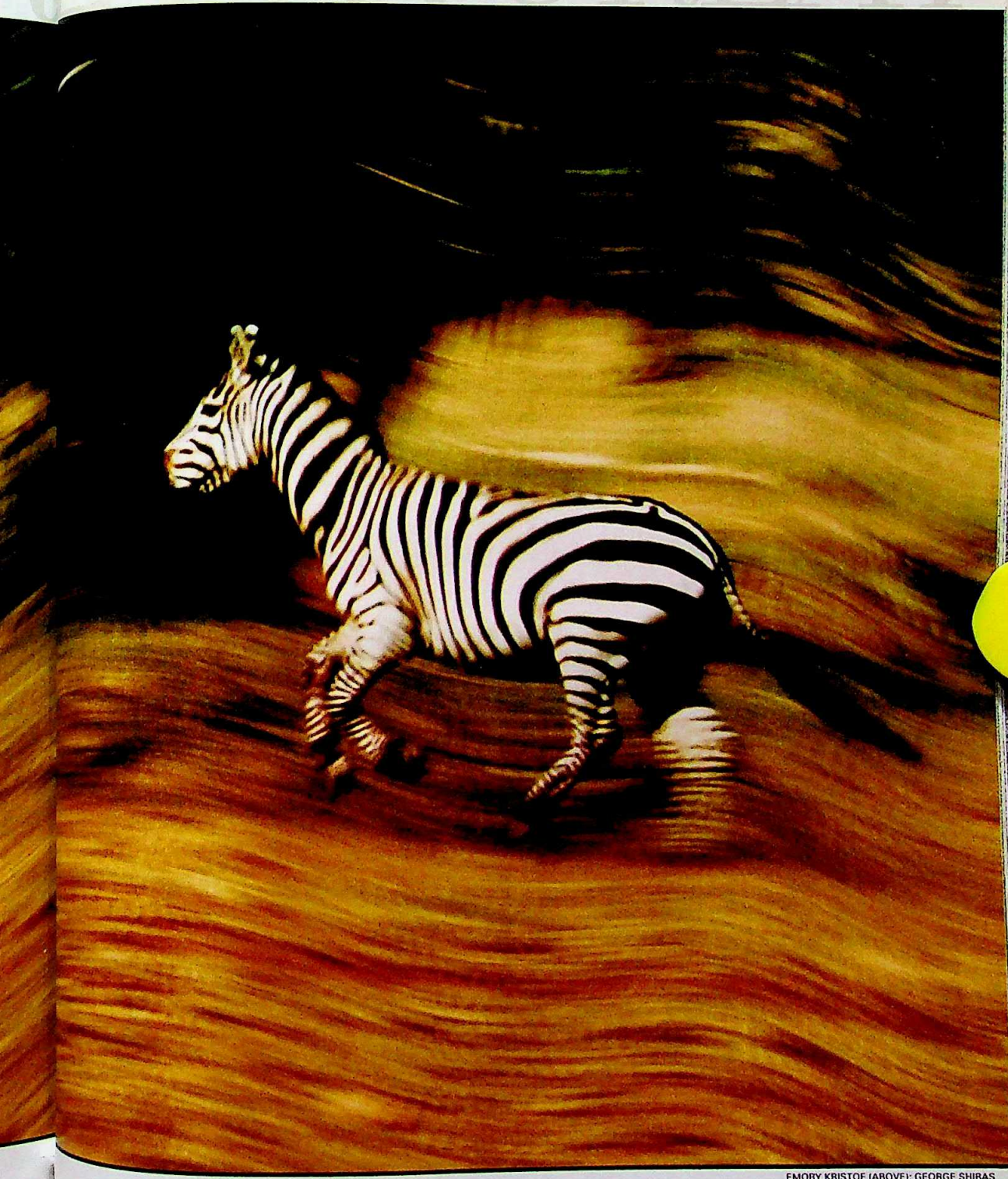
ton captured . . . the hunted quarry." —GEORGE SHIRAS, 1906



EMORY KRISTOF (ABOVE); GEORGE SHIRAS

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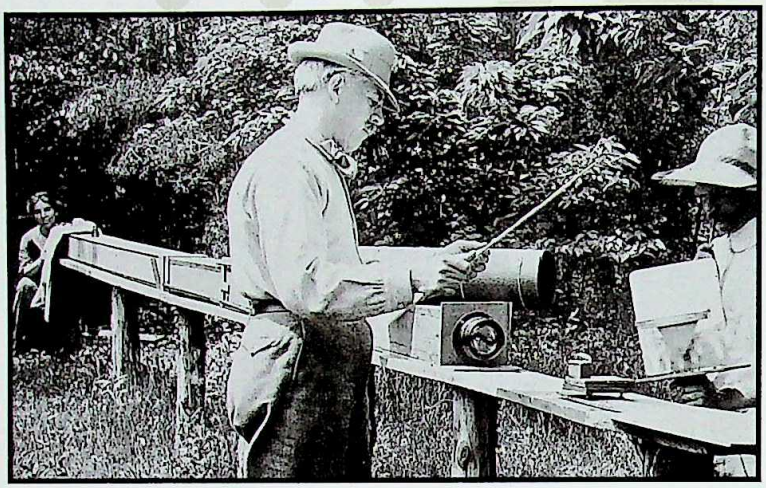
"Every creature has a right to be portrayed



Through his 12-foot-long camera David Fairchild (above) met familiar bugs head-on at 20 times life-size and called them "The Monsters of Our Back Yards" (May 1913). Mark Moffett's regal portrait of a long-horned beetle (right, March 1998) recalls Fairchild's bug's-eye view. To record a jumping spider's mighty one-inch leap from twig to twig (below, September 1991), Moffett needed an ultra-high-speed strobe and days in the studio watching for the merest hint of takeoff. "By the time Mark got the shot," says chief photoengineer Larry Maurer, "he knew that spider personally."

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ved from its own level." —David Fairchild, 1914

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DAVID FAIRCHILD (TOP LEFT); MARK W. MOFFETT

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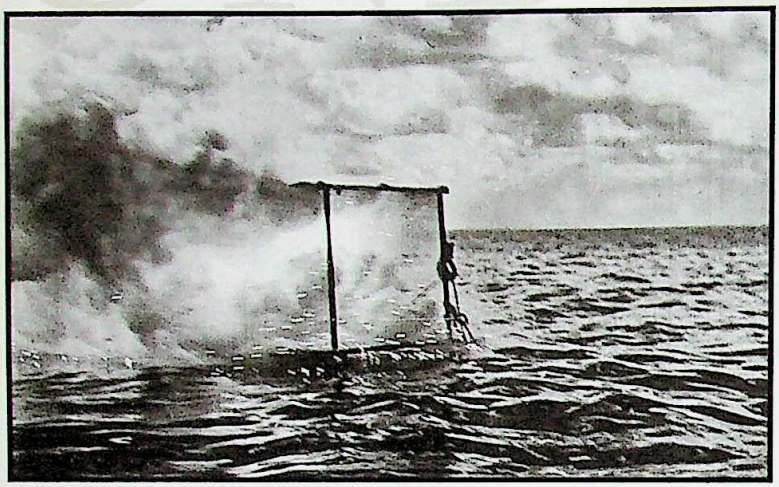
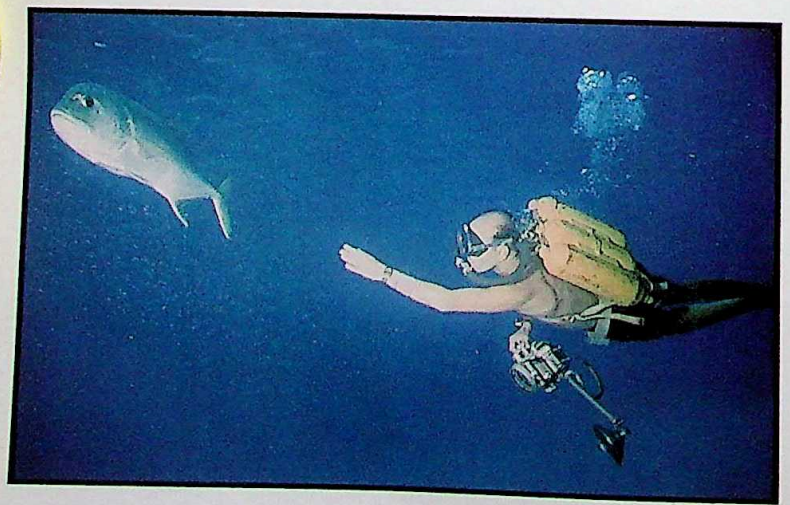
"I seemed to hang . . . in the heart of an



Water eats light—and its appetite grows with depth. To make the first underwater color photographs ever published, Charles Martin and W. H. Longley set off huge charges of flash powder at the surface (above, January 1927). A pioneering proponent of mixing scuba gear with small, nimble cameras and handheld flash, Luis Marden explored the Indian Ocean from Cousteau's *Calypso* (below, February 1956). Working two and a half miles deep, Emory Kristof made his haunting *Titanic* portrait with a pair of submersibles carrying nearly 10,000 watts of high-intensity lighting.



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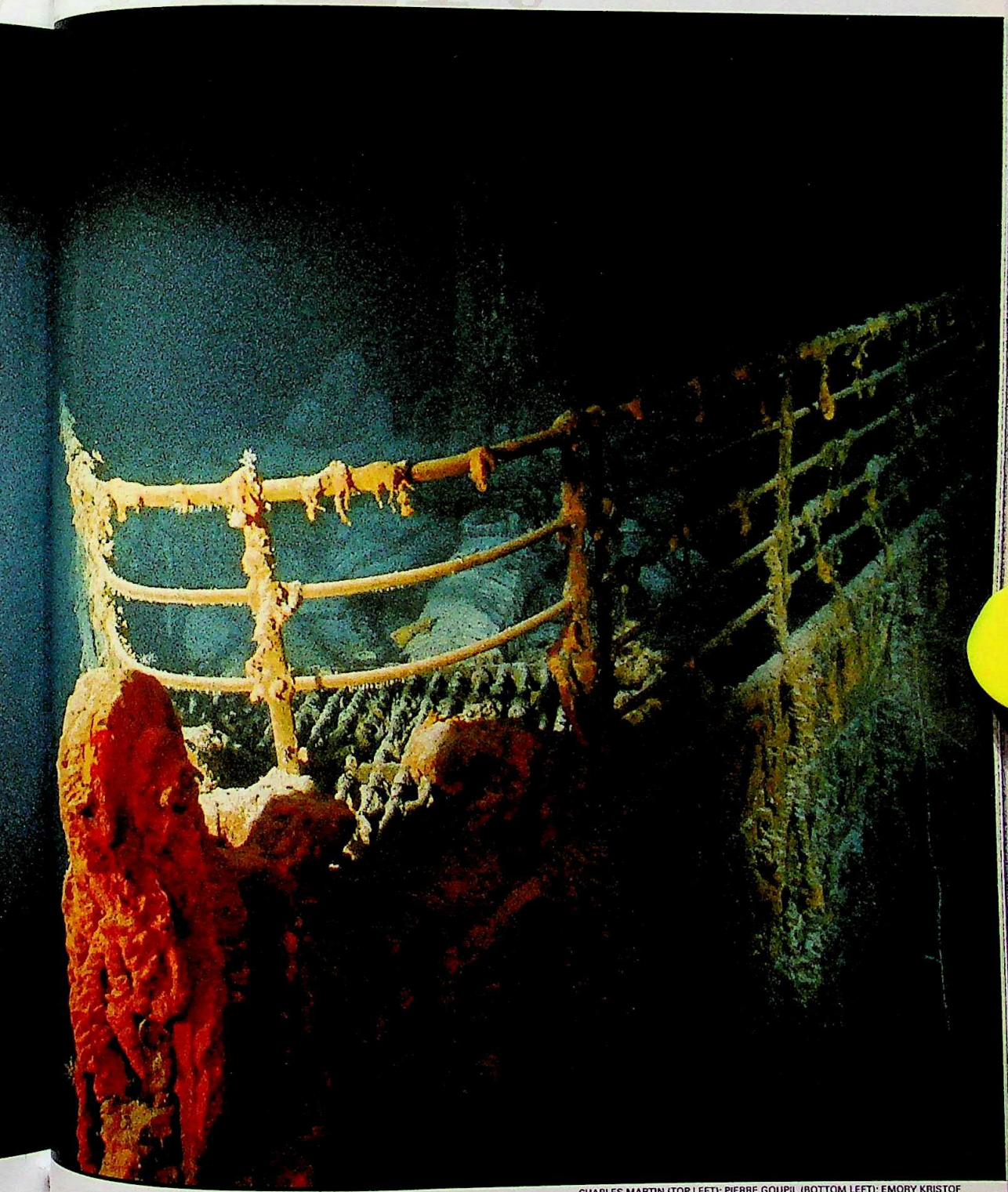
art of an enormous liquid sapphire." —Luis Marden, 1956



CHARLES MARTIN (TOP LEFT); PIERRE GOUPIL (BOTTOM LEFT); EMORY KRISTOF

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Sharks churn the Pacific near Bikini Atoll (June 1992). Photoengineer Joe Stancampiano rigged Bill Curtsinger's camera to a boat-towed housing that rode below the surface. Using a remote shutter trigger, Curtsinger photographed the predators without getting wet—or bitten. "Joe also put a video

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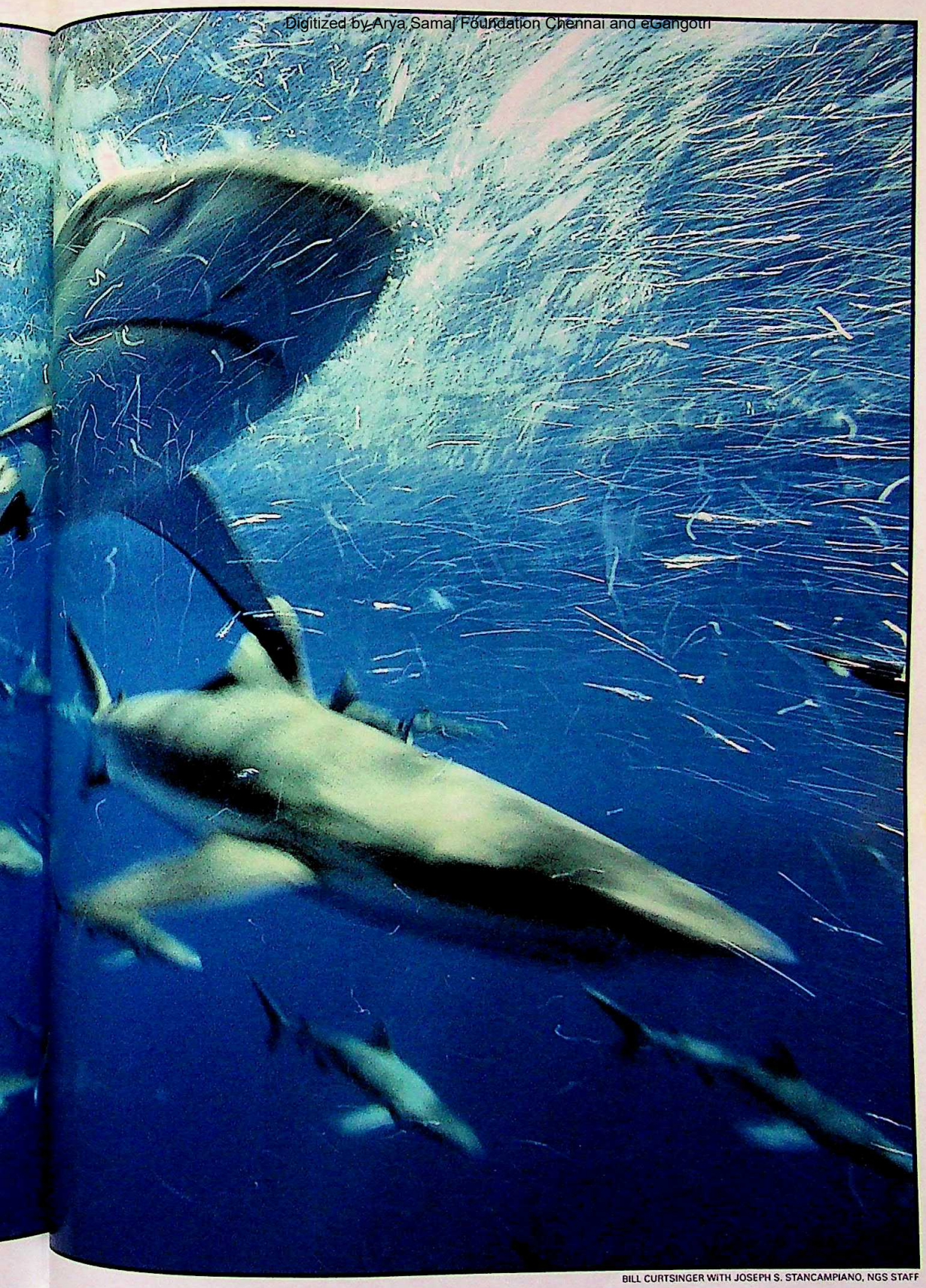

BILL CURTSINGER WITH JOSEPH S. STANCAMPIANO, NGS STAFF

amera in the housing," says Larry Maurer. "A monitor on the boat let Bill see when he had a shot worth taking." Any wishes the photoengineers can't fulfill? "Some laws of physics we can't break," grins Maurer, "but when a photographer comes to us with an idea, we never say it can't be done."

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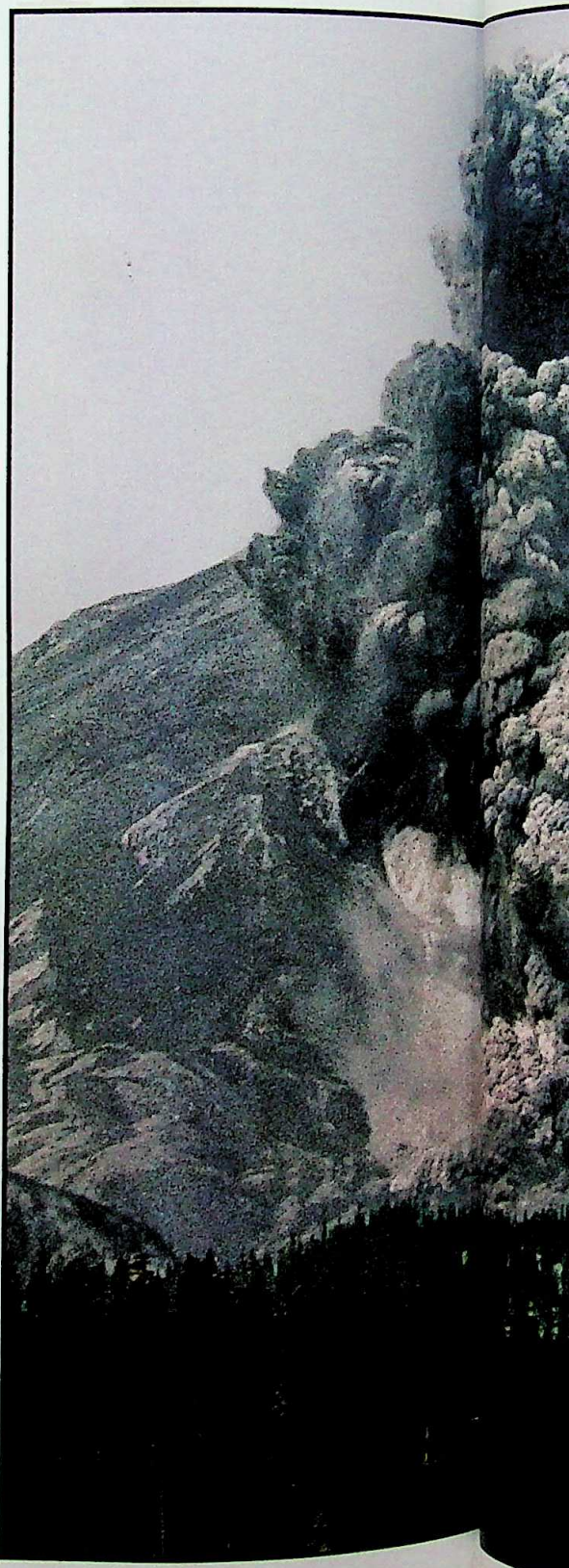
"These events . . . have put a



When Mount St. Helens blew in May 1980, 27-year-old Reid Blackburn was taking photographs for the GEOGRAPHIC eight miles from the summit. He perished. Freelance photographer Robert Landsburg also died in the cataclysm, but his pictures survived to illustrate staff writer Rowe Findley's January 1981 article, along with the work of 20 other photographers, including this movie-like series by Gary Rosenquist (above and right), shot before he fled the onrushing ash cloud.

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avelit a deep track in my mind." —Rowe Findley, 1981

ALL BY GARY ROSENQUIST, EARTH IMAGES

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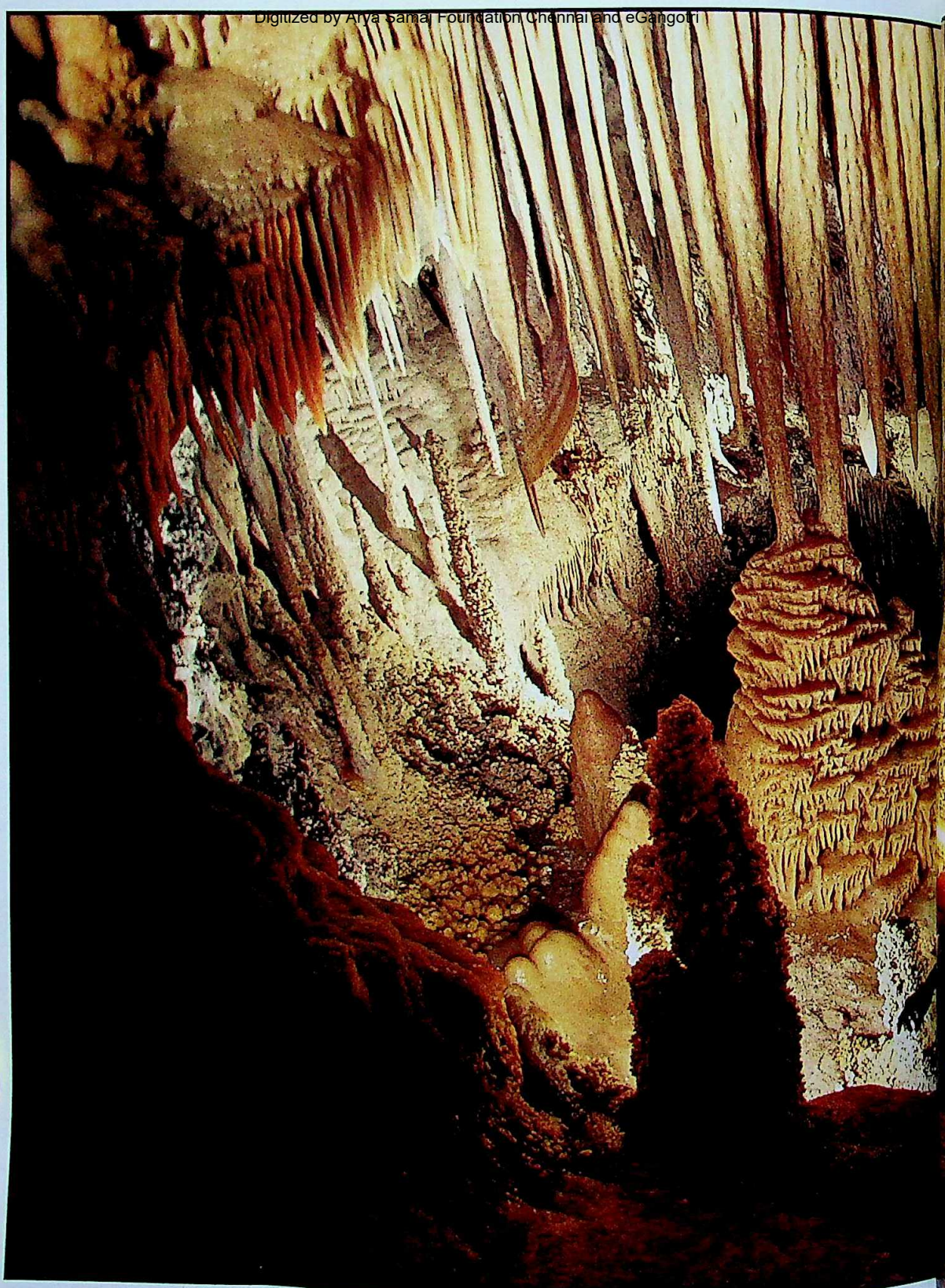

A third of a mile deep in the Earth, blackness is complete. For months photographer Michael Nichols and as many as seven assistants slipped through the narrow entrance of New Mexico's Lechuguilla Cave carrying high-voltage flash units and thousands of flashbulbs to push back the

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NATIONAL GEOGRAPHIC PHOTOGRAPHER MICHAEL NICHOLS

dark (March 1991). Crawling among the fantastical—and fragile—limestone formations with battery packs as big as cigar boxes required great care. "The technology itself was not complicated," says photoengineer Kenji Yamaguchi, "but it took weeks of physical labor to create a single image."

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"Because of the . . . tools of machine vision

Medical imaging has evolved dramatically since 1895, when physicist Wilhelm Konrad Röntgen made his wife's hand (above) the subject of the first x-ray photograph. Chronicling this exploration of inner space, the magazine has helped readers understand diagnostic tools like MRI, magnetic resonance imaging (right, January 1987), which draws a blank on bones but provides detailed images of soft tissue. Scientists first identified HIV, the virus that causes AIDS, in 1983. In June 1986 Lennart Nilsson's scanning electron micrograph showed the deadly virus (above right, in blue) emerging from a major component of the human immune system—a helper T cell magnified 30,000 times.

National Geographic Photographs: The Milestones, new from the Society's Book Division, illustrates the Geographic's impact on photography. To see "Stories of the Century," go to *www.nationalgeographic.com/century.*

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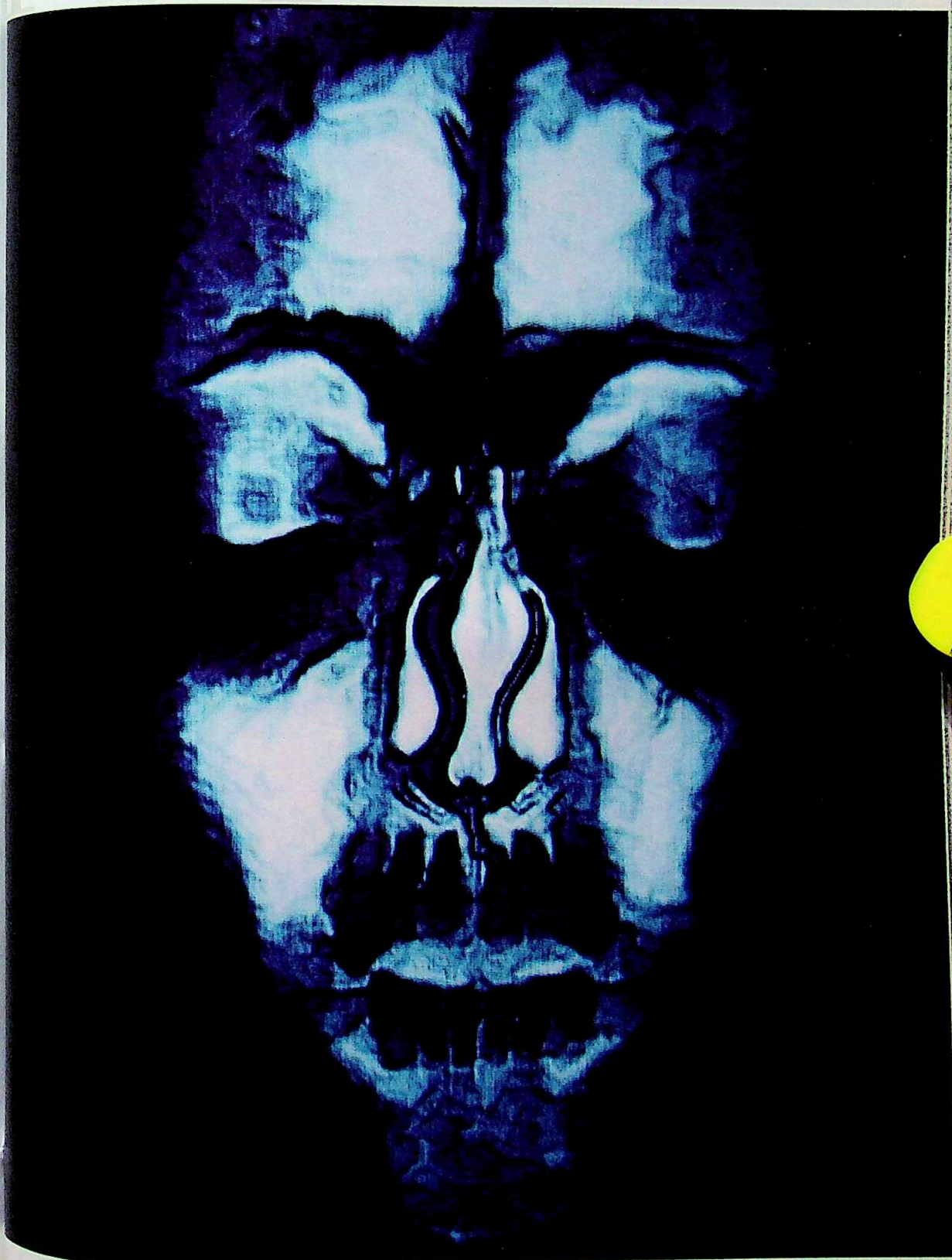
ine vision . . . lives will be saved." —Howard Sochurek, 1987



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DEUTSCHES MUSEUM, MUNICH (FAR LEFT); BOEHRINGER INGELHEIM INTERNATIONAL (LEFT); UNIVERSITY OF KANSAS MEDICAL CENTER

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As the jet neared touchdown at Palmdale, California, photographer Bruce Dale triggered a remotely operated camera mounted on its tail fin: Airport and runway lights blurred into streams of color. This time exposure opened an August 1977 feature on air-traffic safety. Official approval for

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BRUCE DALE

the unorthodox camera installation was tough to get, and airline engineers scrutinized every step. "But the point wasn't to make a gimmicky photograph," says Director of Photography Kent Oberheen. "The point was a visually arresting image, to capture people who didn't expect to be interested."

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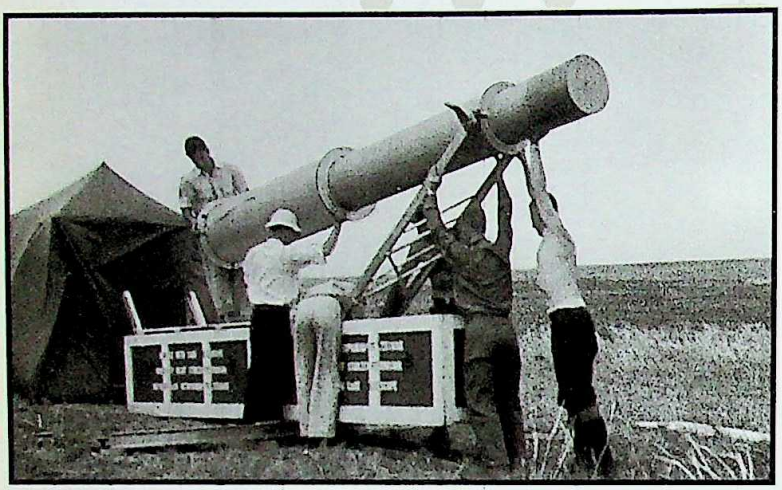
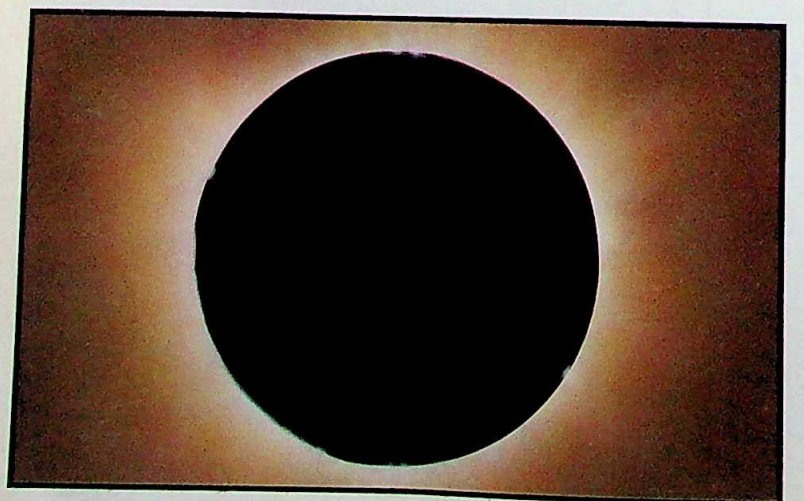
"The impelling motive is . . . an intelligent and



In 1936 Irvine and Merriel Gardner traveled across Russia with a 14-foot-long telescope (above) to make the first color photograph of a solar eclipse (below, February 1937). The eclipse lasted only 117 seconds. To catch the faintest colors of starlight from a mountaintop observatory in Chile (right, May 1988), Roger Ressmeyer synchronized his camera's track with the Earth's rotation for a 20-minute exposure. Such efforts bring the inaccessible and the unfamiliar close to readers "so they can see and understand," says photographer Michael Nichols. "That is what the Geographic does." □



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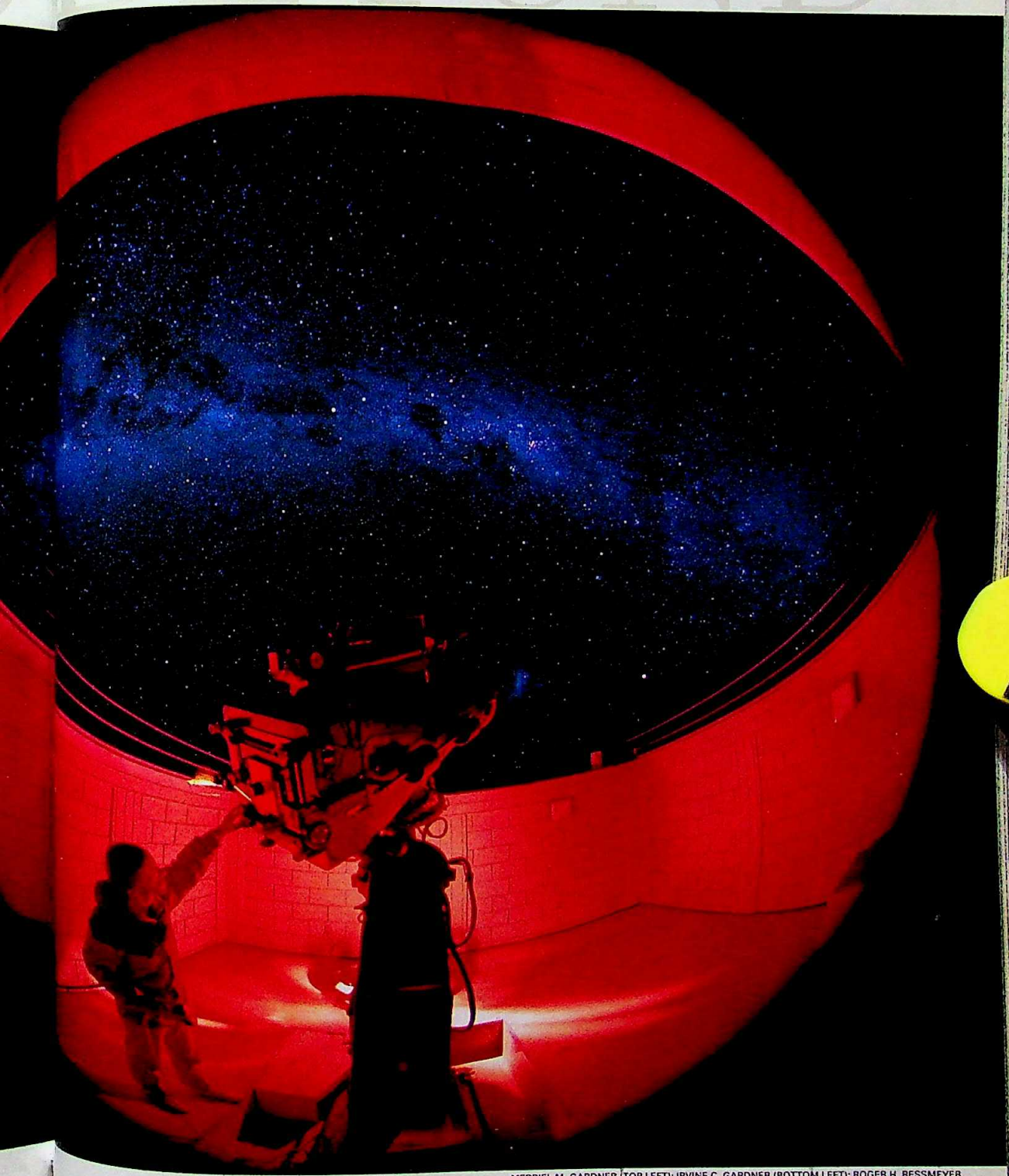
entand justifiable curiosity." —IRVINE C. GARDNER, 1937



MERRIEL M. GARDNER (TOP LEFT); IRVINE C. GARDNER (BOTTOM LEFT); ROGER H. RESSMEYER

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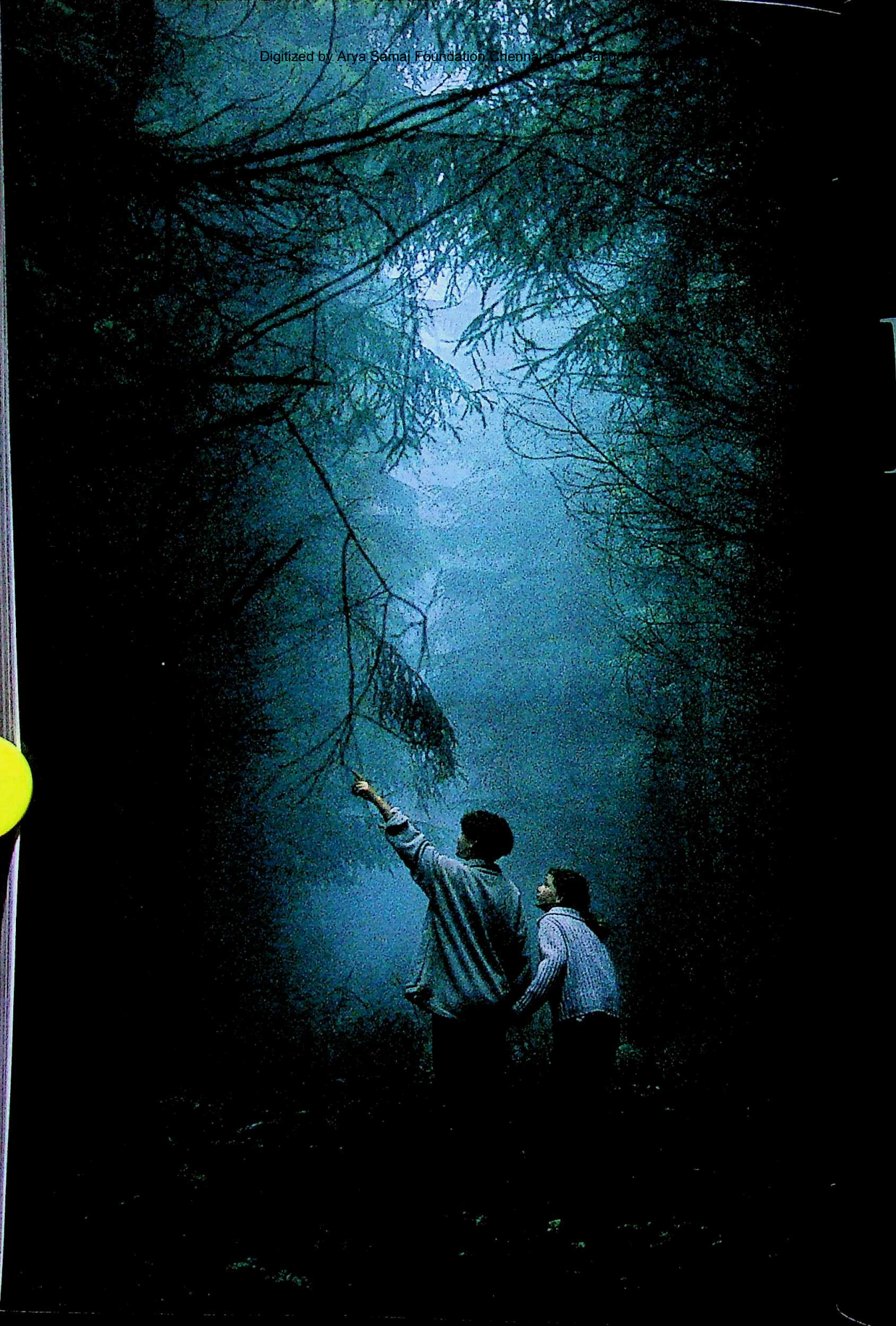

Guardians of the Fairy Tale

The Brothers Grimm

In the early 1800s brothers Jacob and Wilhelm Grimm published a book of fairy tales, largely gathered from storytellers in central Germany. Echoes of the world-famous tales still resound, from castles to deep, dark forests.

BY THOMAS O'NEILL
NATIONAL GEOGRAPHIC SENIOR WRITER

PHOTOGRAPHS BY GERD LUDWIG

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has rought you here? Do come in, and stay with me. No harm shall happen to you." She took them both by the hand, and led them into her little house. Then go

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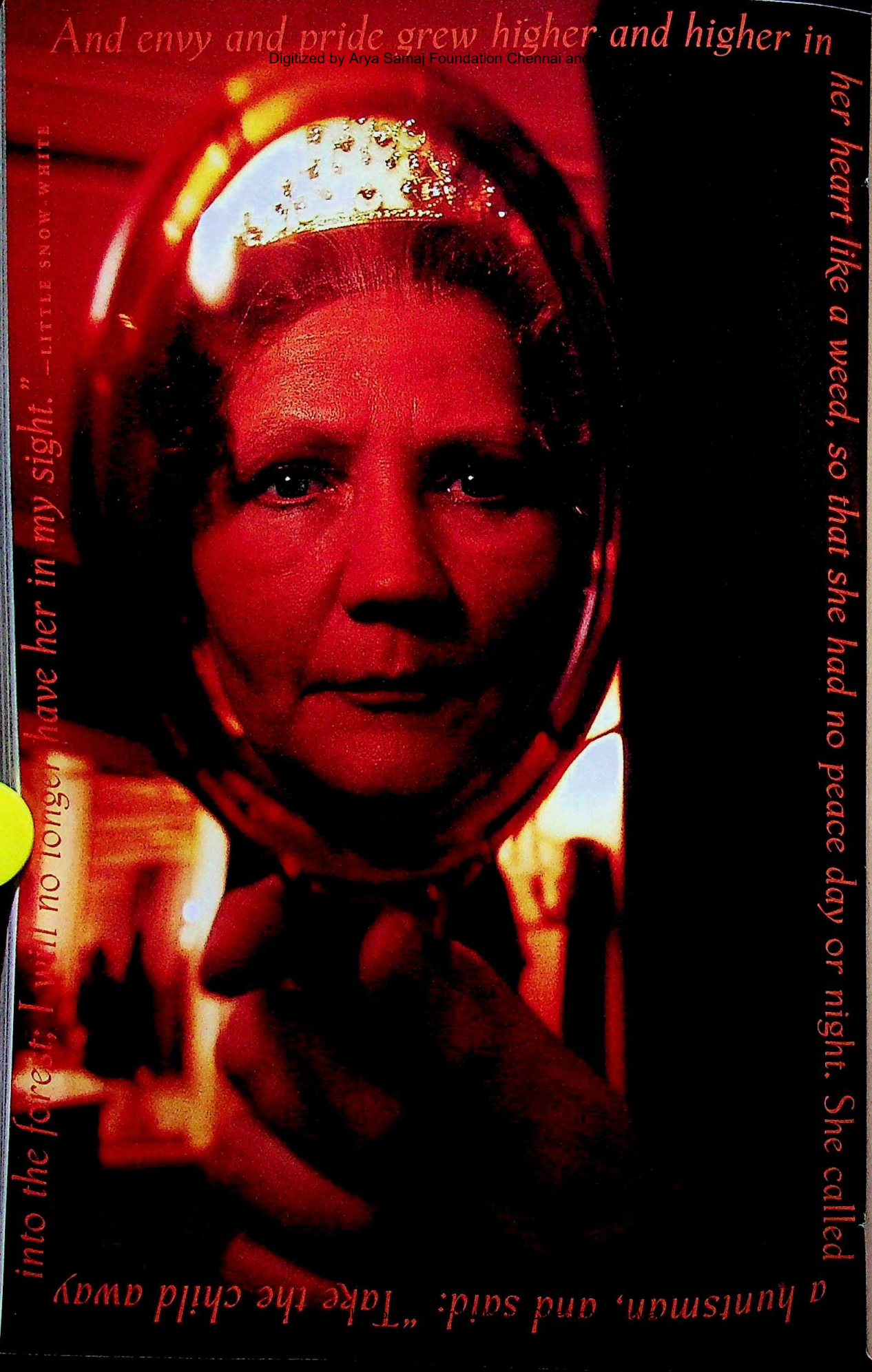

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her heart like a weed, so that she had no peace day or night. She called

nce upon a time

there lived in Germany two brothers who loved a good story—one with magic and danger, royalty and rogues. As boys they played and studied together, tight as a knot,

savoring their childhood in a small town. But their father died unexpectedly, and the family grew poor. One brother became sickly; the other, serious beyond his years. At school they met a wise man who led them to a treasure—a library of old books with tales more seductive than any they had ever heard. Inspired, the brothers began collecting their own stories, folktales told to them mostly by women, young and old. Soon the brothers brought forth their own treasure—a book of fairy tales that would enchant millions in far-away places for generations to come.

The Brothers Grimm, Jacob and Wilhelm, named their story collection *Children's and Household Tales* and published the first of its seven editions in Germany in 1812. The table of contents reads like an A-list of fairy-tale celebrities: Cinderella, Sleeping Beauty, Snow White, Little Red Riding Hood, Rapunzel, Rumpelstiltskin, Hansel and Gretel, the Frog King. Dozens of other characters—a carousel of witches, servant girls, soldiers, stepmothers, dwarfs, giants, wolves, devils—spin through the pages. Drawn mostly from oral narratives, the 210 stories in the Grimms' collection represent an anthology of fairy tales, animal fables, rustic farces, and religious allegories that remains unrivaled to this day.

Grimms' Fairy Tales, as the English-language version is usually called, pervades world culture. So far the collection has been translated into more than 160 languages, from Inupiat in the Arctic to Swahili in Africa. In the United States book buyers have their choice of 120 editions. As a publishing phenomenon the Grimms' opus competes with the Bible. And the stories and their star characters continue to leap from the pages into virtually every media: theater, opera, comic books, movies, paintings, rock music, advertising, fashion. The Japanese, perhaps the most ravenous of all the Grimms' fans, have built two theme parks devoted to the tales. In the United States the Grimms' collection furnished much of the raw material that helped launch Disney as a media giant. Cinderella and Snow White easily hold their own with the new kids on the block, whether Big Bird or Bart Simpson.

As for the brothers, they are recognized as pioneers in the field of folklore research. Their crystalline fairy-tale style—the Grimms extensively edited and rewrote drafts of the narratives—has influenced generations of children's writers and paved the way for other masters of the genre, from Hans Christian Andersen to Maurice Sendak. But the Grimms' stories do not speak only to the young. "The age for hearing these fairy tales is three years to death," says Elfriede Kleinhans, a professional storyteller in Germany. "Our world can seem so technical and cold. All of us need these stories to warm our souls."

A player in Kassel's pre-Lenten festivities waits for a mirror to declare her fairest in the land. Preceding pages: A villager peers into the fiery mouth of the communal oven in Röllshausen.

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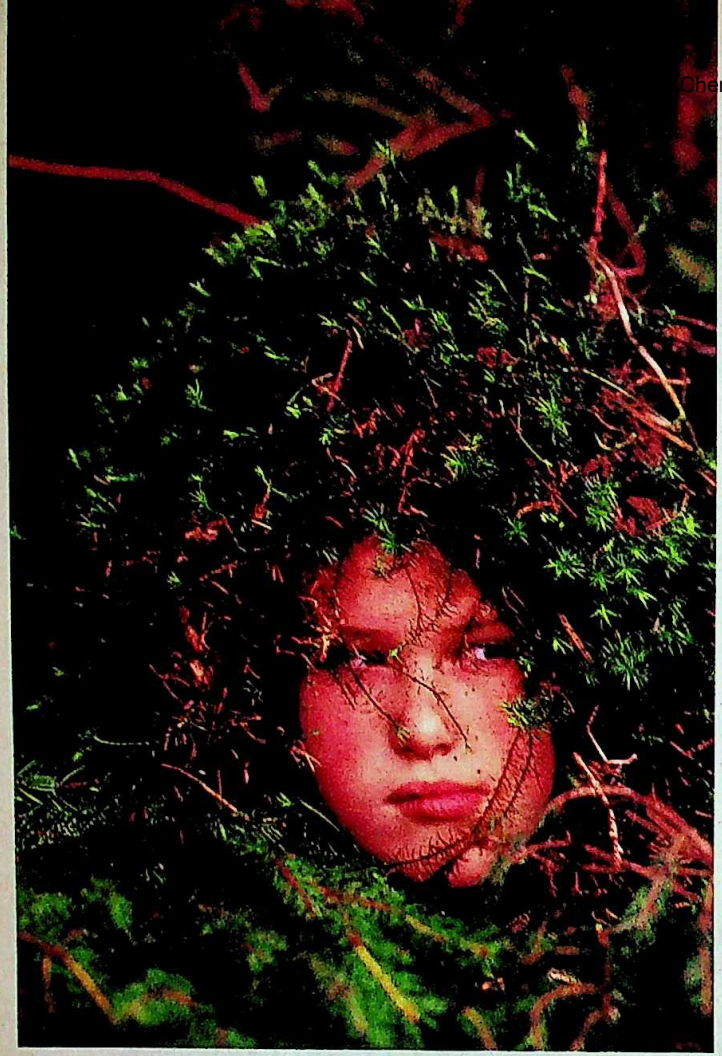
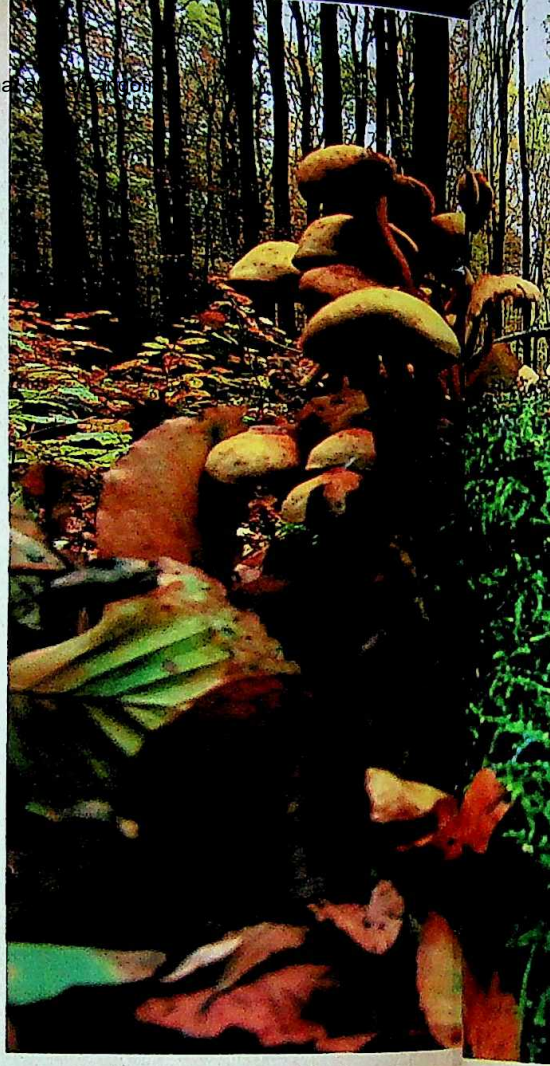
Chennai eGangotri





"As I have lost my way in the forest I should like to

SUCH LASTING FAME would have shocked the humble Grimms. During their lifetimes the collection sold modestly in Germany, at first only a few hundred copies a year. The early editions were not even aimed at children. The brothers initially refused to consider illustrations, and scholarly footnotes took up almost as much space as the tales themselves.

Jacob and Wilhelm viewed themselves as patriotic folklorists, not as entertainers of children. They began their work at a time when Germany, a messy patchwork of fiefdoms and principalities, had been overrun by the French under Napoleon. The new rulers were intent on suppressing local culture. As young, workaholic scholars, single and sharing a cramped flat, the Brothers Grimm undertook the fairy-tale collection with the goal of saving the endangered oral tradition of Germany.

For much of the 19th century teachers, parents, and religious figures, particularly in the United States, deplored the Grimms' collection for its raw, uncivilized content. An American educator in 1885 railed: "The folktales mirror all too loyally the entire medieval worldview and culture with all its stark prejudice, its crudeness and barbarities." Offended adults objected to the gruesome punishments inflicted on the stories' villains. In the original "Snow White" the evil stepmother is forced to dance in red-hot iron shoes until she falls down dead. In "The Goose Maid" a treacherous servant is stripped, thrown into a barrel studded with sharp nails, and dragged through the streets.

Photographer GERD LUDWIG grew up in Germany's Hesse region, home of the Brothers Grimm.

Quotations from *The Complete Grimm's Fairy Tales* by Jacob and Wilhelm Grimm, translated by Margaret Hunt and James Stern. © 1944 Pantheon Books, Inc., renewed 1972 by Random House, Inc.

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to lay here over night." — THE DEVIL WITH THE THREE GOLDEN HAIRS

Even today some protective parents shy from the Grimms' tales because of their reputation for violence.

Despite its sometimes rocky reception, *Children's and Household Tales* gradually took root with the public. The brothers had not foreseen that the appearance of their work would coincide with a great flowering of children's literature in Europe. English publishers led the way, issuing high-quality picture books such as *Jack and the Beanstalk* and handsome folktale collections, all to satisfy a newly literate audience seeking virtuous material for the nursery. Once the Brothers Grimm sighted this new public, they set about refining and softening their tales, which had originated centuries earlier as earthy peasant fare. In the Grimms' hands, cruel mothers became nasty stepmothers, unmarried lovers were made chaste, and the incestuous father was recast as the devil.

Friend or foe? Fairy-tale heroes were never sure which awaited them when they spied a light in the woods, like one from a lonely cabin in the Reinhardswald. Beneath the moss may hide a gnome—or a boy keeping dry.

In the 20th century the Grimms' fairy tales have come to rule the bookshelves of children's bedrooms. And why not? The stories read like dreams come true: Handsome lads and beautiful damsels, armed with magic, triumph over giants and witches and wild beasts. They outwit mean, selfish adults. Inevitably the boy and girl fall in love and live happily ever after. *Read me another one, please.*

And parents keep reading because they approve of the finger-wagging lessons inserted into the stories: Keep your promises, don't talk to strangers, work hard, obey your parents. According to the Grimms, the collection served as "a manual of manners."

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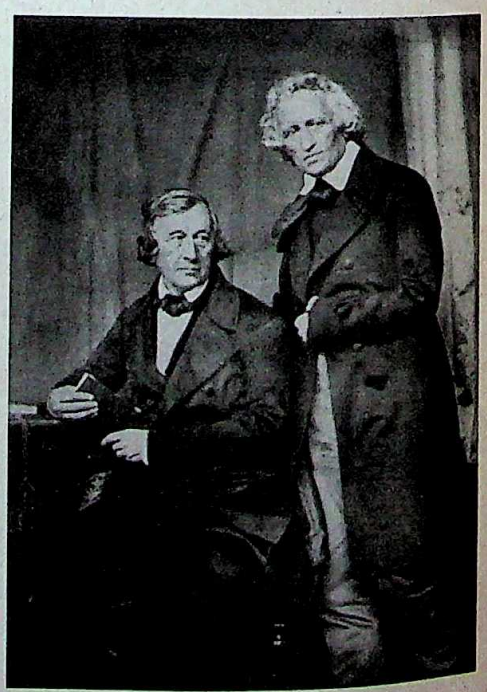
A Family Tale

Serious scholars of medieval literature, the Brothers Grimm began collecting fairy tales as a favor for a friend. Indignant at French rule in their home region of Hesse, the brothers saw in tales like "Hansel and Gretel" and "Rumpelstiltskin" a way to save German culture.

Subjects of an early daguerreotype in 1847, Jacob, standing,



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BOTH FROM THE MUSEUM OF THE BROTHERS GRIMM, KASSEL

and Wilhelm produced seven editions of Children's and Household Tales, *the first in 1812. For illustrations they employed their brother Ludwig, who also drew fantasy figures for the family children (above).*

Many of the 210 stories began life as adult tales in medieval Europe. The brothers recast the narratives in simple, evocative prose, creating classics read today in over 160 languages.

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Americans fell in love with the Grimms' tales when Walt Disney in 1937 released his animated film *Snow White and the Seven Dwarfs*, the first of three wildly popular Disney adaptations. In converting a short story into an 80-minute musical, the Disney studio sweetened the material, giving the dwarfs names like Sneezy and Happy. In *Cinderella* (1950) Disney frosted the plot by adding a carriage that turns into a pumpkin at the stroke of midnight.

THE GRIMMS' TEXTS have undergone so many adaptations and translations, often with the intent of censoring objectionable material such as the violence meted out to villains or of making the themes more relevant to contemporary tastes, that most of us know them only in their sanitized versions. The dust-jacket copy of a recent translation plaintively wonders if all the retellings don't "greatly reduce the tales' power to touch our emotions and intrigue our imaginations."

In a fourth-grade classroom in Steinau, Germany, the town where the Grimms spent part of their childhood, I listened as the storyteller Elfriede Kleinhans, an opponent of prim retellings, asked the boys and girls how the princess managed to turn a frog into a prince at the climax of the "The Frog King," the first tale in the Grimms' collection. "She kissed it," the children sang out. "No," said Kleinhans. "She threw the ugly frog at the wall as hard as she could, and it awoke as a prince. That's what the real story says." The children looked as if they didn't believe her.

Scholars and psychiatrists have thrown a

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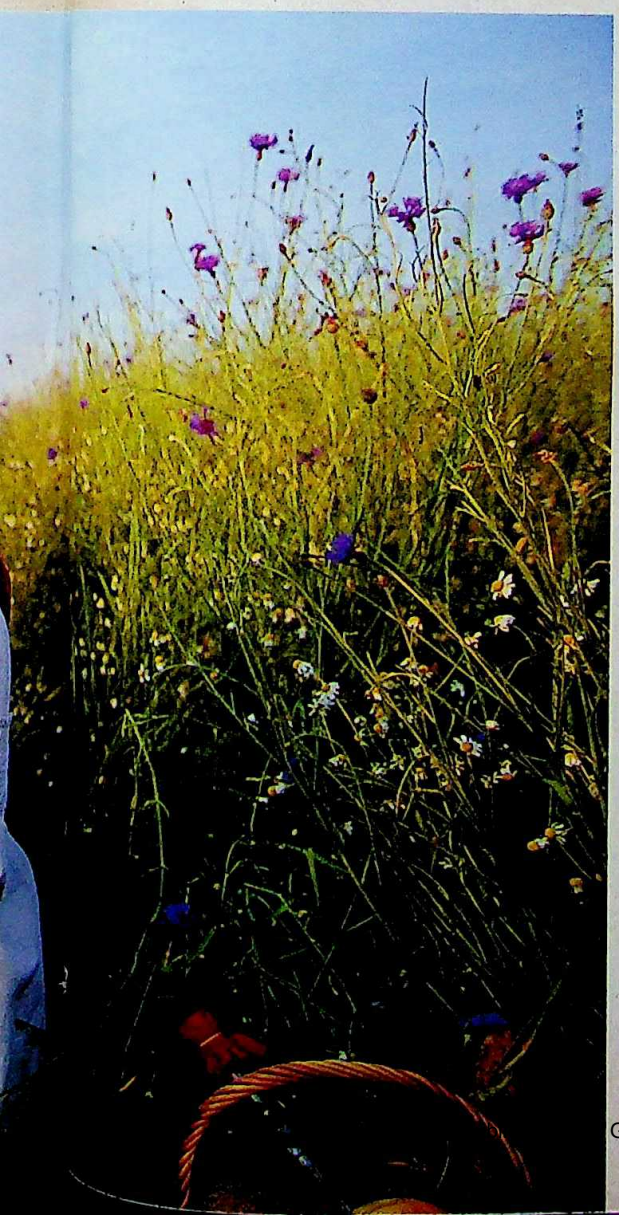
camouflaging net over the stories with their relentless, albeit fascinating, question of "What does it mean?" Did the tossing of the frog symbolize the princess's sexual awakening, as Freudian psychologist Bruno Bettelheim asserted, or does the princess provide a feminist role model, as Lutz Röhrich, a German folklorist, wondered, by defying the patriarchal authority of her father, the king? Or—maybe—a frog is just a frog.

The tales have also fallen prey to ideologues and propagandists. Theorists of the Third Reich in Germany turned Little Red Riding Hood into a symbol of the German people, saved from the evil Jewish wolf. At the end of World War II, Allied commanders banned the publication of the Grimm tales in Germany in the belief that they had contributed to Nazi savagery.

Costumed in the old ways of the Schwalm area, a girl plays as Little Red Riding Hood, heedless of danger.

On campuses across Europe and the United States during the 1970s, the Grimms' tales were scorned for promoting a sexist, authority-ridden worldview. "Madness Comes From Fairy Tales" was scrawled on walls in Germany. Some of the stories were rewritten to accommodate certain political tastes. A revision of "Cinderella," for example, has the heroine organizing a union of local maids, prompting the king to arrest her, after which she emigrates to the U.S. to escape the tyranny of kings and queens.

Asked about this landslide of commentary by shrinks and scholars and ideologues, Bernhard Lauer, director and curator of the Museum of the Brothers Grimm in Kassel, Germany, looked sadly at me and protested, "The tales are literary masterpieces! They are not recipes for everyday life."



ENTHRALLED SINCE CHILDHOOD by the geography of the Grimms' tales—the ominous forests, the brooding castles, the firelit cottages and clamorous village streets—I traveled to Germany to see if I could trace the contours of my imaginary map and possibly discover who these Brothers Grimm really were and how they became the preeminent cartographers of make-believe. My plan was to visit towns in Hesse where the brothers lived and worked to find out who told them the stories and how much the Grimms doctored what they heard. And I would roam the back roads to see if landscapes evoked by the fairy tales still lingered in the Hessian countryside.

Snow streaked the ground in brushstrokes as I drove east from Frankfurt and its glass skyscrapers into Grimm country. Except for their final years in Berlin, Jacob and Wilhelm spent most of their lives in the small towns and provincial cities of today's state of Hesse in the German midsection, close to what—once upon a time—was the border with East Germany. Except for the autobahn's ribbon of concrete and roadside clusters of metal silos, the Hessian countryside today might look remarkably familiar to the Grimms. Red-roofed villages nestle in the folds of hills and along river

Gurukul Kangri Collection, Haridwar

He saw therein a maiden of the greatest beauty! She
t no doubt that she was alive.—THE GLASS COFFIN

ty! She lay as if asleep, and was wrapped in her long fair hair as in a precious mantle. Her eyes were closely shut, but the brightness of her complexion...left no d

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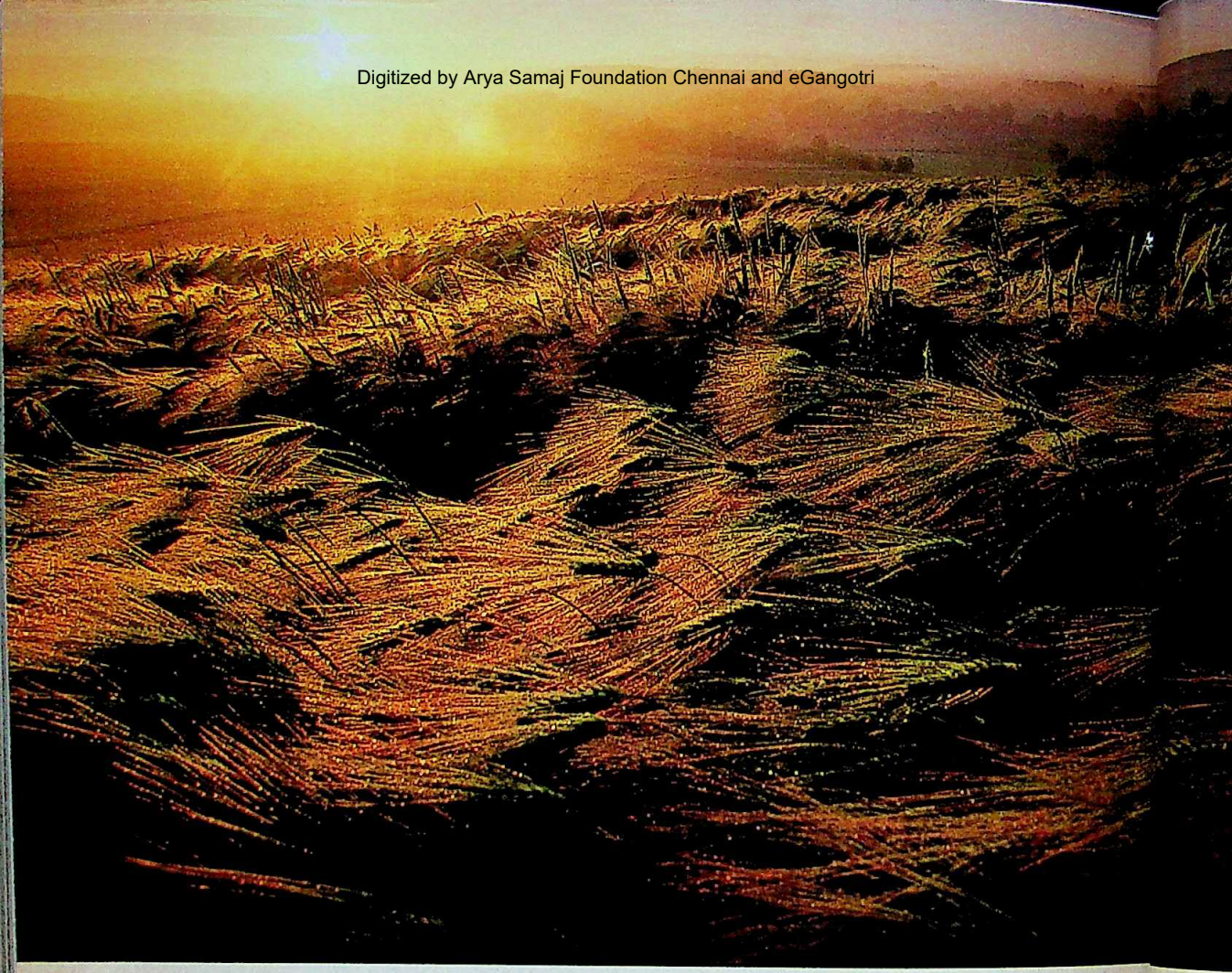

valleys. Stone castles rise from nearby heights, sprouting towers and battlements. Fields that will later ripen with corn and beets roll toward thick forests that frame the horizon like the borders of a woodcut.

The oldest of six children, Jacob and Wilhelm were born a year apart in the mid-1780s in Hanau, a market town less than a day's carriage ride from Frankfurt. Their father, Philipp, the son of a clergyman, was educated in law and served as Hanau's town clerk, a solid middle-class vocation. Father Grimm preached a life of faith, zealous work, and family loyalty. Their mother, Dorothea, gave the boys freedom to wander the countryside where, as Wilhelm later noted, their "collector's spirit" was born as they chased down butterflies and bugs.

Nothing remains of the Grimms' birthplace in Hanau. Like most of the houses they occupied, it was destroyed by aerial bombing during World War II. A bronze statue of the brothers sits in front of the *Rathaus*, or city hall. It features two long-haired men in frock coats absorbed in reading a book, their greatest joy. Tourists regularly gather at its base, their own noses stuck in books, usually travel guides. The statue marks the beginning of the Deutsche Märchenstrasse, or German Fairy-tale Road, a 370-mile route that meanders through central Germany to sites associated with the Grimms or to picturesque places that simply put the traveler in a fairy-tale mood.

By 1791 the family had moved northeast to Steinau, another small trade center, where the father took the position of district magistrate. The Grimms lived well in a large turreted stone house that doubled as the local courthouse. It survives today as a museum of Grimm manuscripts and memorabilia, with revolving exhibits of contemporary fairy-tale illustrators.

At the center of Steinau stands a gaunt 16th-century castle ringed by a grassy moat. Wandering one night through the tiny town, the kind of quiet, uneventful town "where the fox

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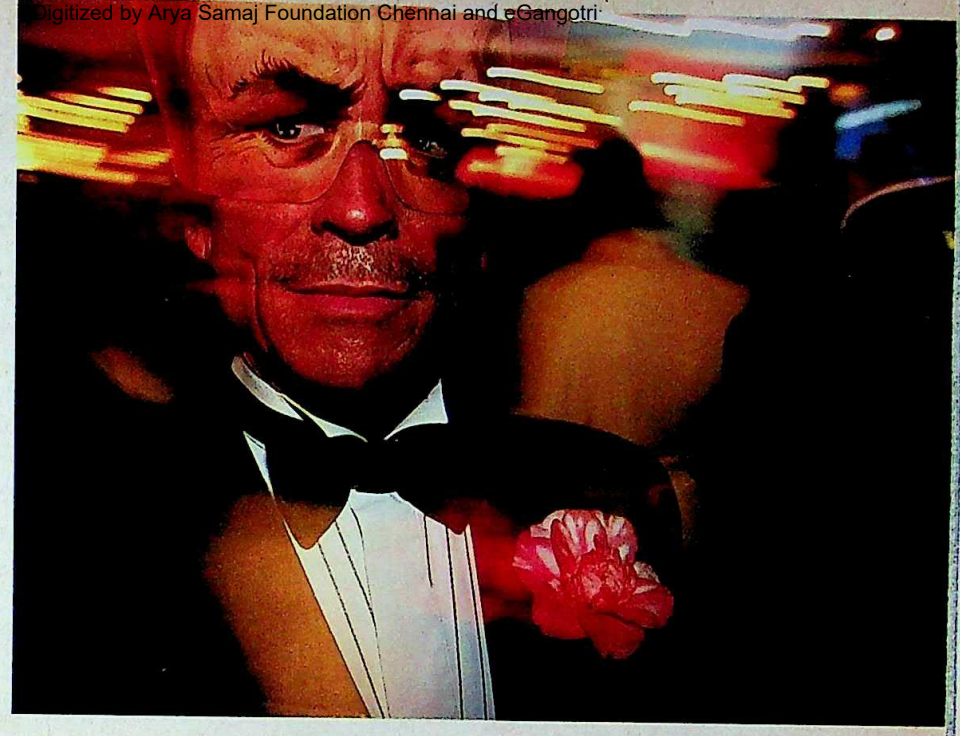

"If by to-morrow morning early you have not spun this straw into gold during the night, you must die."

—RUMPELSTILTSKIN

The alchemy of dawn turns barley into gold. At a masked ball in Frankfurt, a guest looks for his Cinderella. Preceding pages: Sleeping Beauty awaits a prince's kiss in an art show.

and hare say good night to each other," as the Germans say, I entered the moon-shadowed courtyard of the castle and listened to my boots ringing on the cobblestones. In so many of the Grimms' tales an aspiring commoner is ushered into just such a royal space, challenged to make a princess laugh or to bring back three golden hairs from the devil's head. Success meant riches and a royal bride. When the Grimms wrote of castles in their tales, perhaps they remembered this boyhood place.

The Steinau years marked the end of ease and innocence for Jacob and Wilhelm. In 1796 their father died at the age of 44. Dorothea was forced to move her family of six children out of the government residence.

With financial help from Dorothea's sister, a lady-in-waiting for a Hessian princess, Jacob and Wilhelm, at 13 and 12, were sent north to the city of Kassel to attend the Lyzeum, an upper-crust high school. Sharing the same room and bed, the boys coped with loneliness and social slights by studying for ten hours a day. They proved themselves brilliant students, graduating at the top of their classes. The physical effort took its toll on Wilhelm, however. Already of delicate health, he suffered a serious asthma attack at school. Weak lungs and recurring illnesses would vex him the rest of his life.

Like fairy-tale heroes, the Grimm brothers were tested with hard luck and formidable obstacles before it was time for them to meet the wise man who would lead them out of the dark. The meeting took place in the university city of Marburg where Jacob in 1802 and Wilhelm a year later pursued degrees in law. To pick up their trail, I enlisted the help of Rotraut Fischer, a scholar of the German Romantic

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movement. Cloaked in black wool and hoisting a book bag over her shoulder, Fischer led me along steep narrow streets crowded with students. We turned onto Barfüsser Street, passing the half-timbered building where the brothers roomed as poor law students, and started to climb toward the heights of Marburg.

"We know from his letters that Jacob walked this route many times," Fischer said. "In one he complained that there are more steps on the streets than stairs in the houses." We continued past a spiky Gothic church, an organ booming inside, to a three-story stone house just below the town castle. It was here that a young aristocratic law professor, Friedrich Carl von Savigny, impressed by Jacob's appetite for learning, opened his private library to the older Grimm brother. That changed Jacob's life. He spent hours poring over Savigny's collection of rare manuscripts of medieval epics and hero's tales. The experience awoke in Jacob a passion for deciphering and saving ancient German literature and folktales, a cause that his younger brother would also embrace.

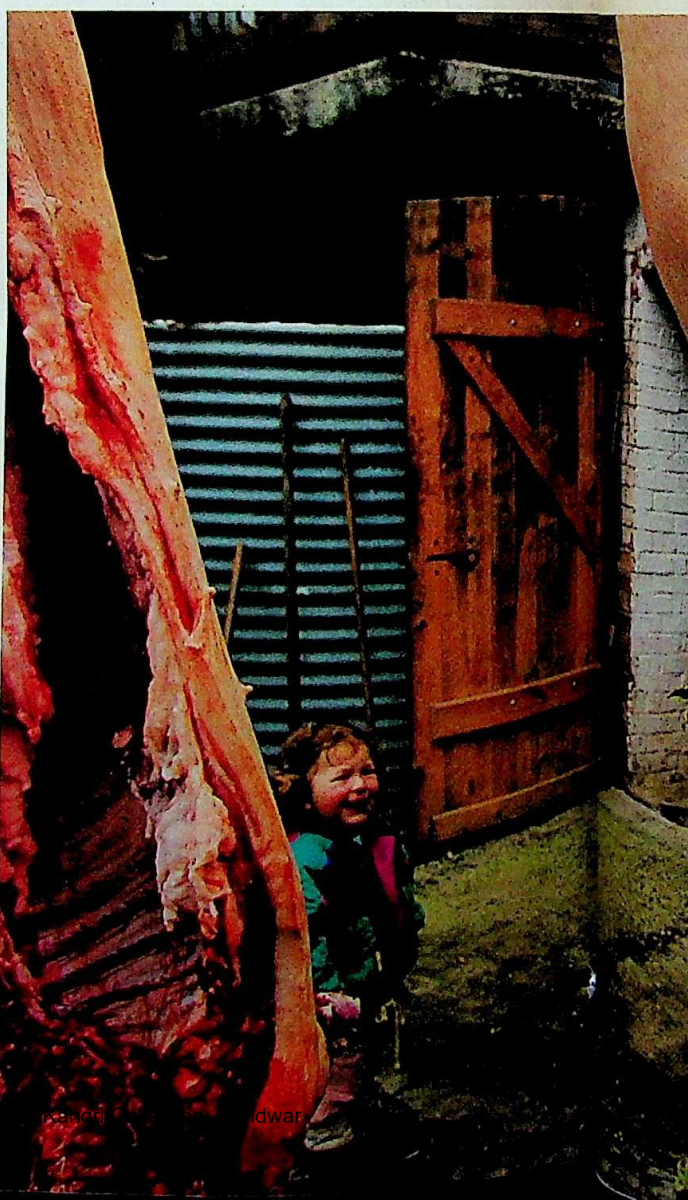
Jacob did not look and act the part of a fiery activist. Short and sturdy, he was by temperament an introvert, his whole being dedicated to bookish research. At Marburg he would decline invitations to stroll the countryside, saying he preferred "a walk in literature." Fellow students called him "the old one." Wilhelm, a determined scholar like his brother, was more outgoing. "Wilhelm had an eye for women, and women had an eye for him," Heinz Rölleke, a Grimm scholar at the University of Wuppertal, told me. Fervent letters passed between Wilhelm and Jenny von Droste-Hülshoff, a wealthy young woman whom he met in a storytelling circle.

Class differences foiled any chance of marriage. Wilhelm at the age of 39 would marry a childhood friend, Dortchen Wild, daughter of a pharmacist and herself a prominent source of fairy tales for the collection. Jacob, a lifelong bachelor, was by far the dominant partner intellectually, initiating most of their projects. Yet the brothers worked well together, signing their joint undertakings simply "Brothers Grimm."

Curiosity and fear duel in a child's expression as a butcher slices a pig in half in a farmyard near Alsfeld.

CHILDREN'S AND HOUSEHOLD TALES, their great collaboration, began in an almost offhand fashion. Immersed in editing and translating medieval manuscripts, the brothers started to gather fairy tales as a favor for a friend planning a collection of German folk literature. After several years the Grimms had assembled 49 tales, taking a few from old books, the rest from acquaintances in Kassel. But when the friend failed to produce the collection, the brothers decided to expand their efforts and publish their own volume.

Collecting fairy tales must have provided Jacob and Wilhelm a welcome distraction from their living circumstances. Their mother had died in 1808. Money grew scarcer. Employed as a librarian for the detested resident French



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ruler, Jacob could barely support his five siblings. Wilhelm was sick from asthma and a weak heart and was unable to work. In 1812, the year the fairy tales were first published, the Grimms were surviving on a single meal a day—a hardship that could explain why so many of the characters in their book suffer from hunger.

Though new editions of the fairy tales continued to appear until 1857, two years before Wilhelm's death, collection of almost all the oral tales took place when the brothers were in their impressionable 20s.

Altogether some 40 persons delivered tales to the Grimms. Many of the storytellers came to the Grimms' house in Kassel. The brothers particularly welcomed the visits of Dorothea Viehmann, a widow who walked to town to sell produce from her garden. An innkeeper's daughter, Viehmann had grown up listening to stories from travelers on the road to Frankfurt. Among her treasures was "Aschenputtel"—Cinderella.

With the exception of Viehmann, the brothers rarely identified their correspondents. Their names and the tales credited to them were learned in most cases only after careful study of the margin notes in the brothers' personal copies of the *Tales*.

The true identity of one of the most important informants—a certain "Marie"—came to light only in the mid-1970s. Marie was credited in the notes with narrating many of the most famous tales: "Rotkäppchen" (Little Red Riding Hood), "Schneewittchen" (Snow White), and "Dornröschen" (Sleeping Beauty).

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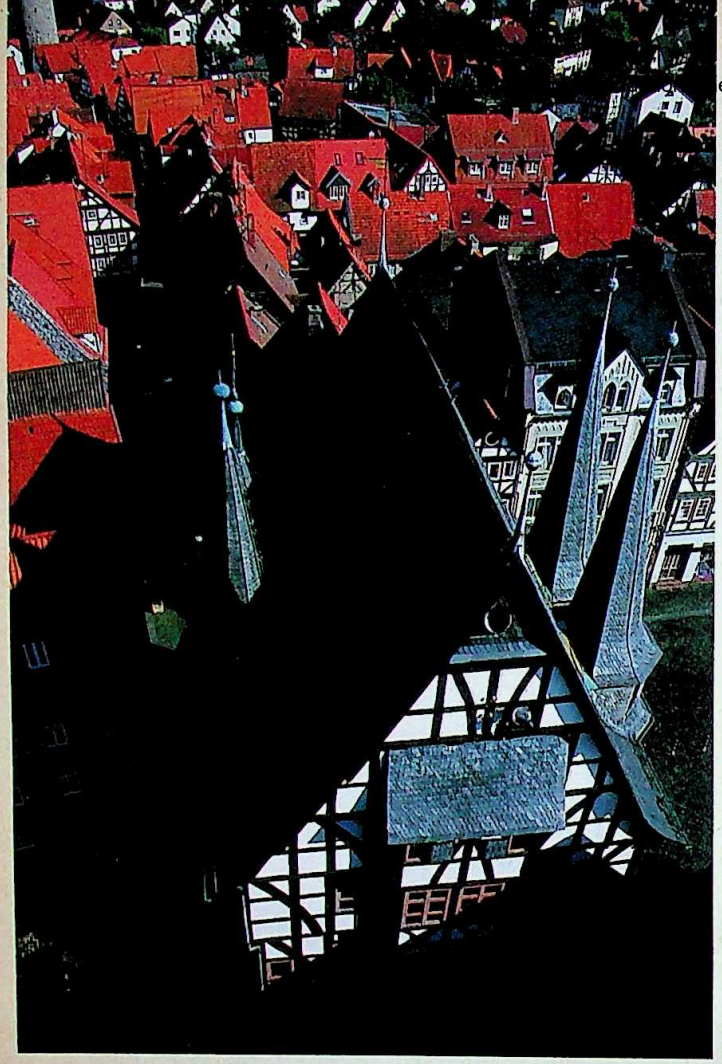
In a moment, numbers of little arth
wo laid in heaps." THE TWO KINGS' CHILDREN

King's daughter commanded. Then said she: "In three hours' time the
arth-men came forth, and asked what the

enn ai and eGangotri



Then he came to a house which seemed very small, for in fron

Herman Grimm, the oldest son of Wilhelm and guardian of the Grimms' legacy after the brothers' deaths, contended for many years that the Marie in question was the old housekeeper of Wilhelm's in-laws.

It took a close reading of the annotations by Heinz Rölleke of the University of Wuppertal to reveal that the storytelling Marie was in fact Marie Hassenpflug, a 20-year-old friend of their sister, Charlotte, from a well-bred, French-speaking family.

I ENCOUNTERED A LIKENESS of Marie on a wall in Wolfgang Hassenpflug's house in Rinteln. Herr Hassenpflug, a retired engineer with a poet's head of unruly white hair, is the great-great-grandson of Charlotte Grimm, known as Lotte in family circles. In 1822, he explained, 29-year-old Lotte left the household of her five brothers and married a longtime family friend, Ludwig Hassenpflug, a brother of Marie. Because the direct lines of Jacob and Wilhelm appear to have died out with the death of Wilhelm's daughter in 1919, Wolfgang Hassenpflug now finds himself the inheritor of many Grimm family treasures, as well as mementos from the Hassenpflug lineage.

The walls of Hassenpflug's elegant stone house are hung with original portraits of the Grimm brothers and of their sister and her family—copperplate prints all etched by a third brother Grimm, Ludwig. Marie looks out with large soulful eyes, her thin face framed by dark curls.

For my visit Hassenpflug's wife, Gerda, dressed a table for lunch with one of Lotte's original damask tablecloths, with "LG" stitched in one corner. Wolfgang told the story of Marie's "rediscovery" and explained how the family's French-Huguenot background

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for in front of it a great giant was standing. — THE RAVEN

A steadfast knight in Trendelburg shows how to defeat witches and dragons. Old half-timbered buildings cluster in Alsfeld. Preceding pages: Industrious as fairy-tale dwarfs, schoolchildren clear a wet forest trail.

influenced her storytelling ability. "Like the Grimms she grew up in Hanau, which at the time was a very French town," Hassenpflug said. "Her nursemaids naturally told French stories. The Grimms may at first have thought Marie's tales all came from Hesse, but the famous ones we now know came from France and the book by Charles Perrault."

Marie's wonderful stories blended motifs from the oral tradition and from Perrault's influential 1697 book, *Tales of My Mother Goose,* which contained elaborate versions of "Little Red Riding Hood," "Snow White," and "Sleeping Beauty," among others. Many of these had been adapted from earlier Italian fairy tales. In the second edition of their own collection the Grimms acknowledged the deep international roots of many of their tales. Included in their notes are references to variants from many other cultures, including Russian, Finnish, Japanese, Irish, and Slavic.

Long before the Grimms' time, storytelling thrived in the milieu of roadhouses, barns, and, perhaps most energetically, in the *Spinnstuben,* the spinning chambers of peasant women. During winter nights women softened the long hours of spinning flax into yarn by entertaining themselves with tales spiced with adventure, romance, and magic. The Grimm tales feature many spinners, most famously in "Rumpelstiltskin," in which a poor miller's daughter, ordered by a king to spin straw into gold—failure means death, success a royal marriage—enlists the aid of a devilish little man, Rumpelstiltskin.

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flying over it. This lasted for many years.... — IRON HANS

no one would any longer venture into the forest,

and it lay there in deep stillness and solitude, and nothing was seen

of it, but sometimes an eagle or a hawk flyin

The smell of the delicious dishes which were being taken in and out reached her, and now and then the servants threw her a few morsels....

—KING THRUSHBEARD

GIVEN THAT THE ORIGINS of many of the Grimm fairy tales reach throughout Europe and into the Middle East and Orient, the question must be asked: How German are the Grimm tales? Very, says scholar Heinz Rölleke. Love of the underdog, rustic simplicity, sexual modesty—these are Teutonic traits.

The coarse texture of life during medieval times in Germany, when many of the tales entered the oral tradition, also colored the narratives. Throughout Europe children were often neglected and abandoned, like Hansel and Gretel. Accused witches were burned at the stake, like the evil mother-in-law in "The Six Swans." "The cruelty in the stories was not the Grimms' fantasy," Rölleke points out. "It reflected the law-and-order system of the old times."

Patrons feast at a medieval banquet in Wetterburg Castle. Avoiding the poison red ones, foragers pick wild mushrooms. Preceding pages: An ancient beech haunts a gloomy forest.

Possibly the most German touch of all is the omnipresence of the forest, the place where fairy-tale heroes confront their enemies and triumph over fear and injustice. Rural German society traditionally depended on the *Wald*. The forest was where farmers grazed their pigs on acorns, royals hunted deer, and woodcutters selected logs for the massive beams still seen in the half-timbered barns and houses of Hessian towns.

Storytellers knew that to place characters in a dark trackless woods would stir up associations of danger and suspense. "The forest was not seen as a safe place. Townspeople would avoid it," forester Hermann-Josef Rapp told me as we drove wet logging roads through the Reinhardswald, a large forest in the hills of northern Hesse. "There were outlaws and

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Arya Samaj

illegal hunters. And Germans have always been afraid of wolves."

Nowadays the Reinhardswald is thick with beech and introduced spruce, serving local sawmills. But to behold those mighty oaks that were the preferred species in most Grimm fairy tales, one has to visit a remnant forest near Sababurg Castle. Rapp, a trunk of a man in a green oilskin jacket, led me into that forest one day in a pouring rain. Here massive, arthritic-looking oaks, some of them 400 years old or more, loomed like Gothic ruins. I spooked myself staring at the thick, grasping limbs, the wild hairlike mosses, the knobby eyes, the holes that gaped like mouths. How could Little Red Riding Hood's mother ever have let that sweet little girl go into such woods as these?

Despite the strong Germanic flavoring of the tales, the first edition sold poorly. At the Grimms museum in Kassel, director Bernhard Lauer placed the brothers' personal copy of the first edition in front of me, handling it as if it were a Fabergé egg. "It's the most valuable thing in the museum," he said, "Only a few of the original 900 copies still exist. The paper quality was very poor."

Mild commercial success did not come until 1825, when the Grimms published the *Small Edition*, a condensed collection of 50 stories with illustrations by their brother Ludwig. The 1825 volume, of which 1,500 copies were printed, is even rarer than the 1812; only four or five copies survive in libraries. With the debut of the cheaply priced *Small Edition*, the Grimms had at last figured out who their true audience was: children.

By the second edition in 1819 Wilhelm had taken over the lead responsibility for the fairy tales, Jacob having turned his attentions to

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a scholarly exegesis on German grammar. Wilhelm proved an inspired editor. By streamlining plots to emphasize action, weaving into the narrative old proverbs and folk poems, and using poetic language to set scenes, Wilhelm created a style that remains a model for fairy-tale writing.

Wilhelm continued to polish and reshape the tales up to the final edition of 1857. Comparisons of the various editions reveal that in his effort to make the stories more acceptable to children and their middle-class parents, Wilhelm removed any hint of sexual activity, such as the premarital couplings of Rapunzel and the prince who climbed into her tower. He also added Christian motifs, accented the child-rearing lessons of the tales, and emphasized gender roles. Though the brothers implied that they were mere recorders of tales, such literary and moral restylings of oral narratives were apparently crucial to bring the tales into the mainstream. "Yet despite all Wilhelm's additions," Rölleke said, "the cores of the stories were left untouched."

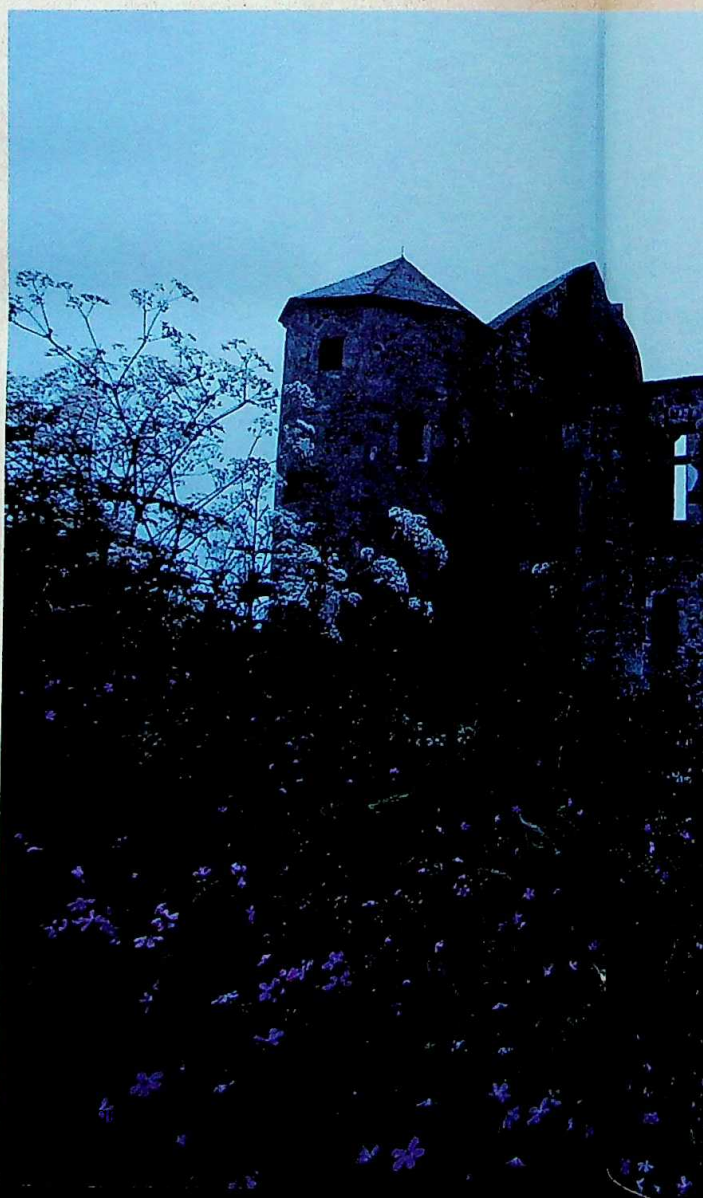
The editorial fingerprints left by the Grimms betray the specific values of 19th-century Christian, bourgeois German society. But that has not stopped the tales from being embraced by almost every culture and nationality in the world. What accounts for this widespread, enduring popularity? Bernhard Lauer points to the "universal style" of the writing. "You have no concrete descriptions of the land, or the clothes, or the forest, or the castles. It makes the stories timeless and placeless."

The tales allow us to express "our utopian longings," says Jack Zipes of the University of Minnesota, whose 1987 translation of the complete fairy tales captures the rustic vigor of the original text. "They show a striving for happiness that none of us knows but that we sense is possible. We can identify with the heroes of the tales and become in our mind the masters and mistresses of our own destinies."

Fairy tales provide a workout for the unconscious, psychoanalysts maintain. Bruno Bettelheim famously promoted the therapeutic value of the Grimms' stories, calling fairy tales the "great comforters." By confronting fears and phobias, symbolized by witches, heartless stepmothers, and hungry wolves, children find they can master their anxieties. Bettelheim's theory continues to be hotly debated. But most young readers aren't interested in exercising their unconscious. My 11-year-old daughter, Lucy, thinks it's cool that witches cast spells and that heroines always seem to get their man. Boys I know go for stuff like the cloak that makes a hero invisible and a rifle that never misses.

The Grimm tales in fact please in an infinite number of ways. Something about them seems to mirror whatever moods or interests we bring to our reading of them. This flexibility of interpretation suits them for almost any time and any culture.

Jacob and Wilhelm moved on from their



Abandoned for a hundred years, Sababurg Castle has awakened as a hotel fit for make-believe.

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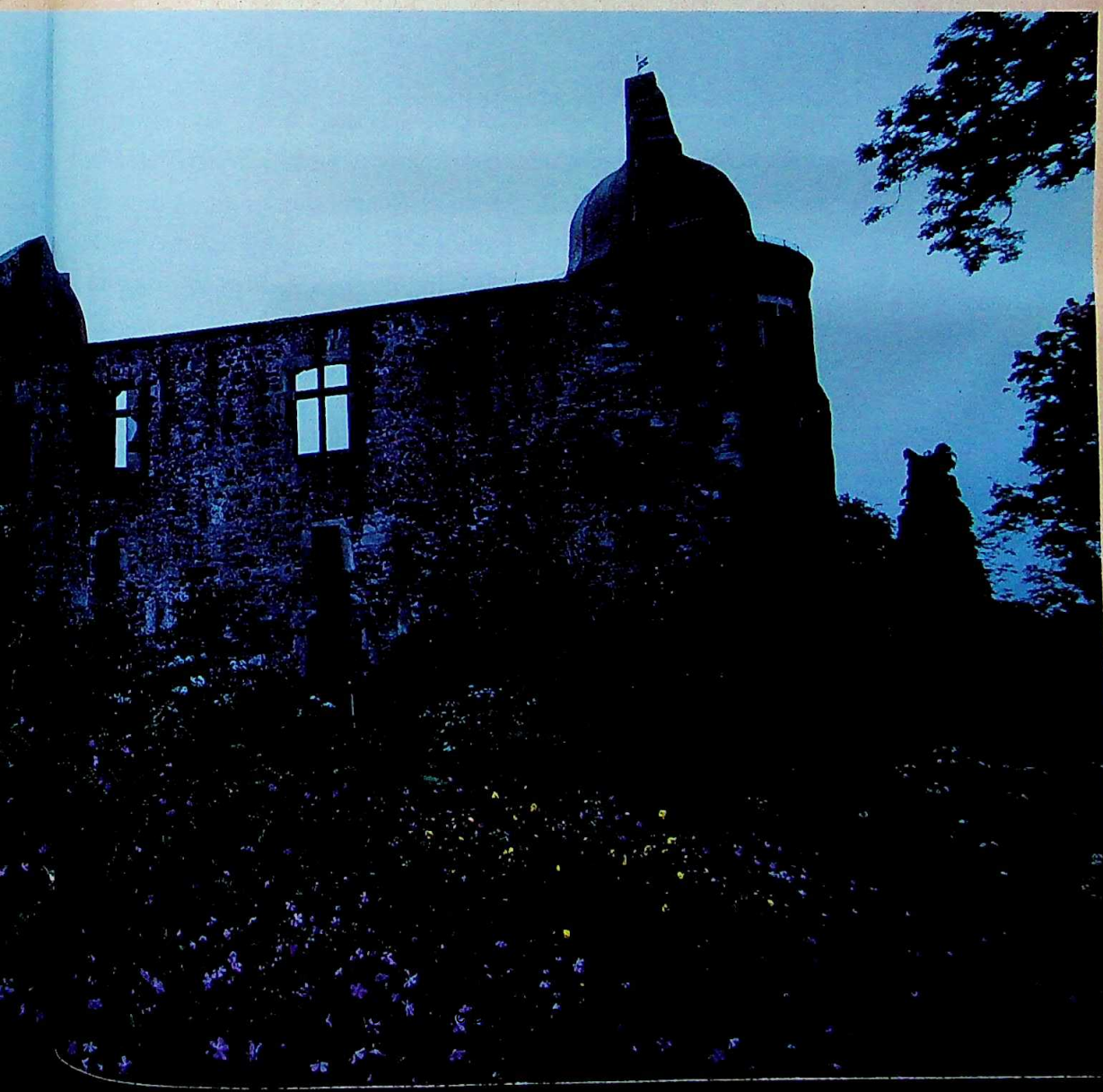
jobs as librarians in Kassel to teach at universities in Göttingen and Berlin. Between them they published more than 35 books. The brothers also made a name for themselves as patriots, risking their livelihoods by speaking out in favor of democratic reform. But in their last years they retreated from politics and teaching to concentrate on writing the *German Dictionary,* one of the most ambitious scholarly projects of 19th-century Europe.

The brothers did not live to finish the dictionary or to see the fulfillment of their abiding dream: the founding in 1871 of the German nation. Wilhelm died of an infection in 1859 at the age of 73. Jacob in his eulogy bestowed upon his beloved Wilhelm the name *Märchenbruder,* the "fairy-tale brother." Jacob died four years later. He had just finished writing the dictionary definition for *Frucht,* or fruit, a fitting end to a fertile life.

The Brothers Grimm, for the final fairy tale in their collection, chose a short, parable-like tale called "The Golden Key." A poor boy goes out into a wintry forest to collect wood on a sled. In the snow he finds a tiny key and near it an iron box. The boy inserts the key. He turns it. He lifts the lid.

That is where the story ends. For once the brothers avoid a tidy ending. Instead, they have issued a golden invitation, since accepted by countless readers, to open the brothers' books with the key of the imagination. Only then can readers discover what wonderful things await them. □

Read tales from the Brothers Grimm and more at *www.nationalgeographic.com/grimm.*



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SURVEY 2

Charting Communities and Change

By Valerie A. May

ARE PEOPLE KIND? Do they feel close to their community? What do they like to eat, read, listen to? Survey 2000 sought to answer these questions and more in a pioneering effort to use the World Wide Web to collect information on geographic mobility, cultural identity, Internet use, and other patterns in contemporary life. In partnership with Northwestern University, and with the assistance of a dozen scholars and social scientists, the National Geographic Society offered everyone with access to our website, *nationalgeographic.com,* the opportunity to help take a snapshot of the way we live and think about ourselves on the eve of a new millennium. ■ Why a Web-based survey? The explosive expansion of the Internet has transformed the way we communicate, do business, teach, and entertain ourselves—but the potential for learning about ourselves has barely been tapped. Would information gathered from responses to an Internet questionnaire be useful? We concluded that it would if the survey met several criteria, among them a large and diverse group of Web respondents. The final tally: More than 80,000 people from 178 countries and territories logged on to Survey 2000. ■ Schools, libraries, and community centers cooperated by hosting "map the global village" sessions that offered computer and survey access to the public. Newspapers and magazines published articles that generated interest. Then for ten weeks in the fall of 1998 survey takers collectively spent more than two million minutes online at *nationalgeographic.com.* Each participant answered one of three questionnaires: for U.S. and Canadian adults, for adults from other countries, or for children. Questionnaires were computer customized, generating questions based on a participant's previous answers. ■ More than 50,000 people from 5 to 96 years old completed the survey, spending an average—and amazing—44 minutes doing so. Here are some early findings from U.S. respondents: The adult population is indeed transient. Sixty percent no longer live in the state they were born in. Of those who do, Washington staters come in first, but folks from the Middle Atlantic region are more likely to stay within 30 miles of

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2000

PENNY DE LOS SANTOS

Questions on a computer screen from Survey 2000 are reflected in the glasses of 14-year-old Kelsey Lutz, one of 14,334 children (with 65,678 adults) to log on to the survey—a groundbreaking effort to use the Internet for social science research.

where they were born. Native Dakotans and people from Montana and Wyoming are most likely to move out of state. ■ Mobility does not necessarily lead to a breakdown in positive feelings about community: More than 80 percent believe that "people are kind"; 90 percent believe that they have something positive to contribute to society. ■ On a less serious note: Pizza was voted the most popular food; french fries and hamburgers tied for second place; buttermilk pie and Indian pudding are at the bottom. The most recognized authors: Mark Twain, Ernest Hemingway, and John Steinbeck. Stephen King was sixth, Danielle Steel 27th. In music, oldies/classic rock topped the charts, followed by classical. Dead bottom: heavy metal and rap/hip-hop. ■ About 7,000 U.S. children told us about themselves. Nearly 85 percent of those 13 to 15 years old worry about the environment. About 60 percent of those disagree with the statement: "All in all the world population will be better off in the next 100 years." Most would accept cuts in their standard of living to conserve global resources. ■ These findings are preliminary—the tip of a data iceberg. Researchers continue to study the information gathered and expect to find it a valuable resource for years to come. To view results of the questionnaires, go online to *http://survey2000.nationalgeographic.com.*

VALERIE MAY is director of news and editorial programming for the Geographic website.

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SURVEY 2000

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Snapshot of Society

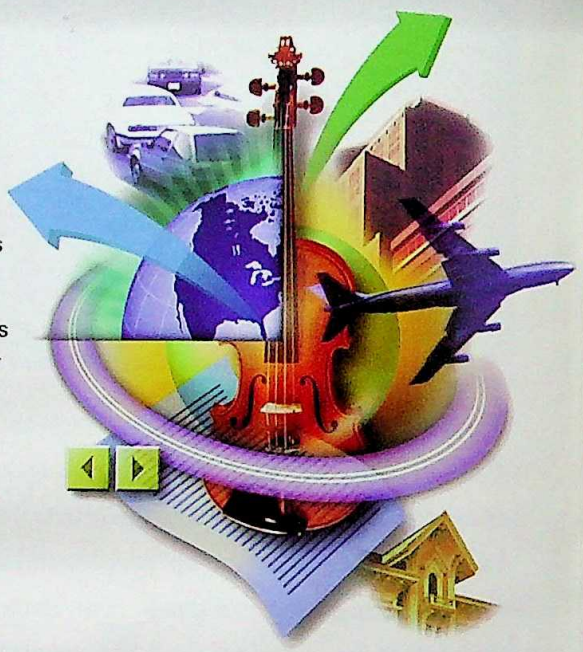
THE LARGEST INTERNET-BASED SURVEY of its kind drew 80,012 participants from around the world, including 697 who had never used the Net before. The charts at right profile the 40,612 U.S. adults who logged on. Their demographic profiles are compared with those of the General Social Survey (GSS), a prominent biennial study that queries 3,000 representative Americans. Participants in Survey 2000 were self-selected and needed computer access, but the detailed information they provided, coupled with the large sample size, offers scientists valuable data that can't be found anywhere else.

40,612 U.S. adults provided data.

Mobility and Cultural Identity

WITH CHAINS such as Starbucks, Wal-Mart, and Taco Bell spread across the country, the lines between regional cultures seem to blur. Is this mobile society—Americans move their residences once every five years on average—becoming one vast McCulture? Survey 2000 results indicate that regional variety is far from extinct. "It is clear, for instance, that the prairie states [West North Central region] have a strong area literature," says sociologist Wendy Griswold. Respondents from these states consistently recognized Garrison Keillor and Sinclair Lewis (Minnesota), Jane Smiley (Iowa), Laura Ingalls Wilder (South Dakota), and Willa Cather (Nebraska). Outsiders also know these writers, suggesting that modern, mobile life has not stilled regional voices. Further, Griswold found that people who had moved into some regions knew its literature better than the natives did. She thinks that newcomers may have a stronger need to discover the essence of their adopted home.

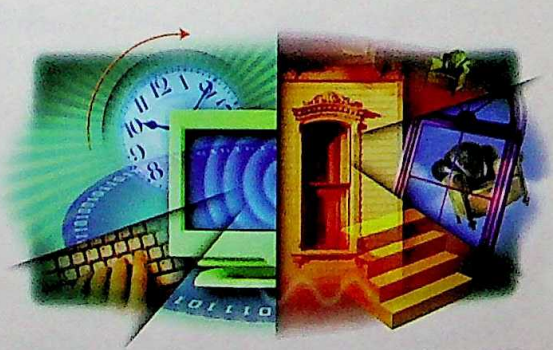
"Joining behavior also seems to fall into regional patterns," says sociologist James Witte. Survey takers from the West North Central, East South Central, and West South Central regions were most likely to belong to school, farm, and religious groups—and least likely to belong to ethnic-based organizations or book clubs. New Englanders and those from the Pacific region favored environmental and social-advocacy groups—and were least likely to join religious organizations.



15.9% have always lived within 30 miles of their current address.

Charting Digital Communities

INTERNET USERS are becoming a more diverse group. Compared with longtime users, survey participants who were new to the Net were three times as likely to have a high school diploma or less and were twice as likely to be African Americans. Today's Internet community more closely mirrors the general population. Overall, Netters use the medium to enhance their daily lives. The computer screen does not replace books though. Netters are readers. They also use the Net for social contact: They're more than twice as likely to e-mail long-distance friends as to telephone them. "But it's not a substitute for personal contact," cautions communication researcher Malcolm Parks. "Those who used the Net more also made more visits, wrote more letters, and made more phone calls."



Respondents who regularly contact friends and relatives are ten times as likely to use the Internet as write letters.

ART BY TOM WHITE; GRAPHS BY DAVID FIERSTEIN AND TOM WHITE
U.S. DATA COMPILED BY JOE GERMUSKA, LISA AMOROSO, PHILIP HOWARD, NATHAN WRIGHT, AND LORI KOWALESKI-JONES

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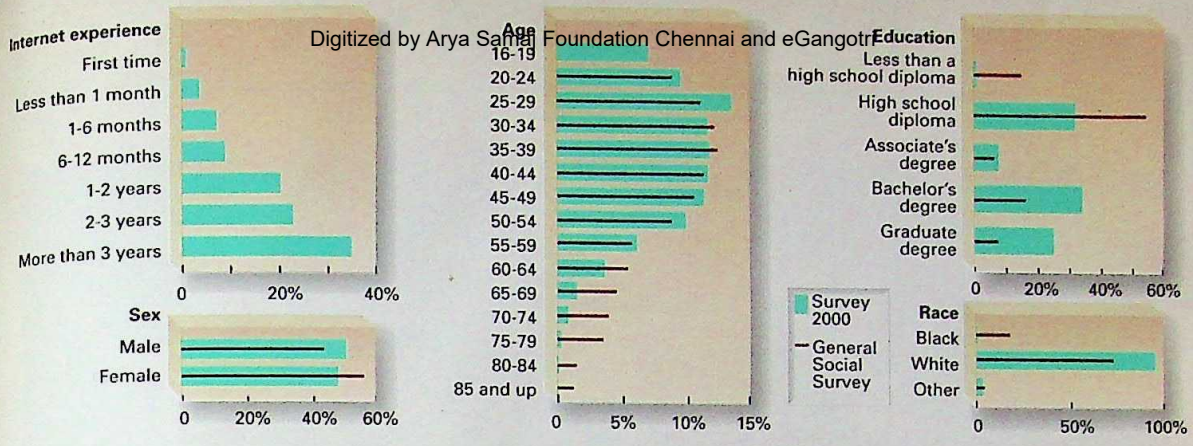
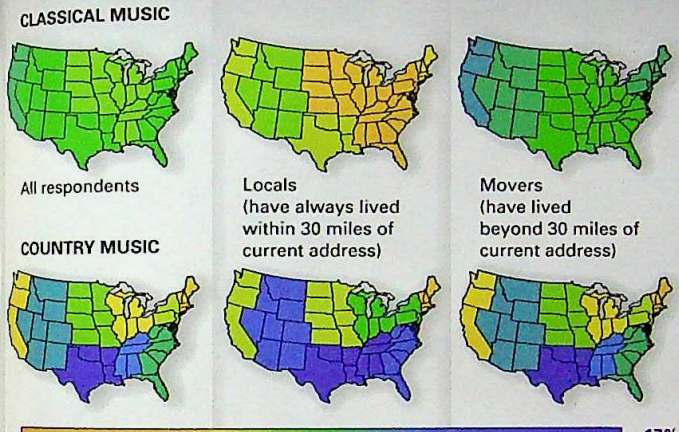
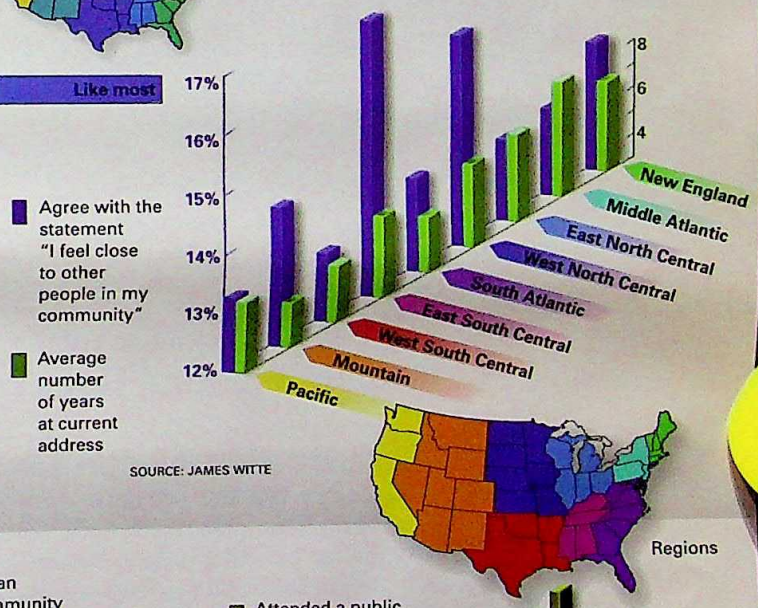




SOURCE: RICHARD PETERSON

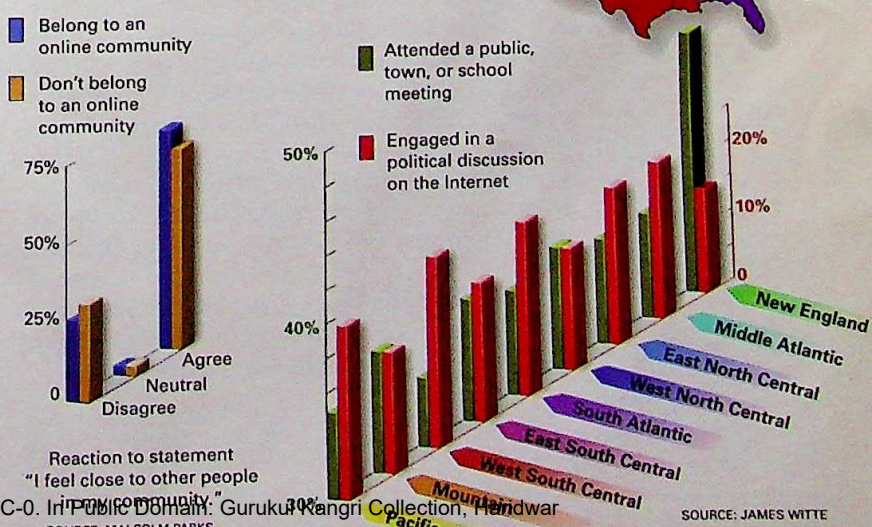
■ **CLASSICAL VS. COUNTRY** Are you more likely to enjoy Garth Brooks if you live in Texas than in New Jersey? Absolutely. Chances of being a Vivaldi fan in Florida? Not nearly as great as if you lived in California. According to our survey, musical taste reflects residence and mobility. Movers like classical more than stayers do. In the South and Southwest movers and stayers like country and western, more so than their counterparts elsewhere.

■ **STAYING VS. BELONGING** Conventional wisdom—and a substantial body of research—suggests that increased mobility undercuts a sense of community. But do stayers feel community spirit? People from New York, New Jersey, and Pennsylvania tend to remain within 30 miles of their birthplace more than others elsewhere in the country. Yet respondents from those states were among the least likely to regard their community as a source of comfort.



SOURCE: JAMES WITTE

■ **VIRTUAL VS. REAL** Internet users who belong to an online community (e.g., chat group) report a strong sense of geographic community (graph at right). New Englanders, who are most likely to attend public meetings, turned to the Net the least to talk politics (far right). Conversely, in regions where participation in public meetings is lowest, political discourse via the Net is highest. □



SOURCE: MALCOLM PARKS

SOURCE: JAMES WITTE

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■ FROM THE GEOGRAPHIC ARCHIVES

What Interesting Hats You Have

Black-and-white photography couldn't capture the scarlet-capped girls of Hesse, Germany—even though, as the Grimm brothers' tale has it, the wolf did. Grimm scholars now know that the story of "Little Red Riding Hood"—or "Little Red-Cap"—was first published in France in 1697. But residents of Hesse's Schwalm region prefer to believe that the fairy tale, collected by the Grimms as oral folklore in the early 1800s, was inspired by the traditional red headpieces, known as *Betzeln,* worn by local girls. The hats cover a braided topknot and are part of an elaborate costume, still worn on holidays, that broadcasts age and marital status. Both girls and boys dress in red to symbolize youth and vitality.

Purchased during staff writer Frederick Simpich's travels through Germany in 1920, this photograph has never before been published in the GEOGRAPHIC.

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KEY TO 1999

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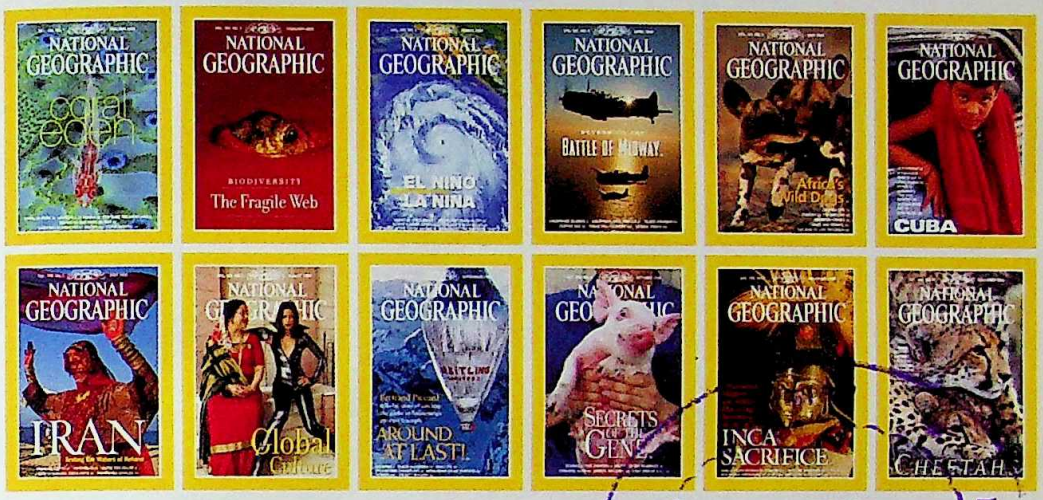

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CLOSED DOORS opened to GEOGRAPHIC readers in 1999. Twice they saw the face of Cuban culture, in June and October. A look at Iran came in July, and at Iraq in November. Members also learned in November of newly discovered birdlike dinosaur fossils. Today's flora and fauna were examined in February's biodiversity issue—part of a special millennium series—followed by a human counterpart on global culture in August. To track memorable articles from recent years, a cumulative index for 1989 through 1998 is available for $15.95. The first 110 years of the GEOGRAPHIC, 1888-1998, are available on CD-ROM for $99.95 and on DVD-ROM for $119.95, plus postage and handling. To order, call 1-800-437-5521 or write to NGS, PO Box 11650, Des Moines, IA 50340-1650. An online index can be searched by going to *www.nationalgeographic.com* and clicking "NGS Publications Index."

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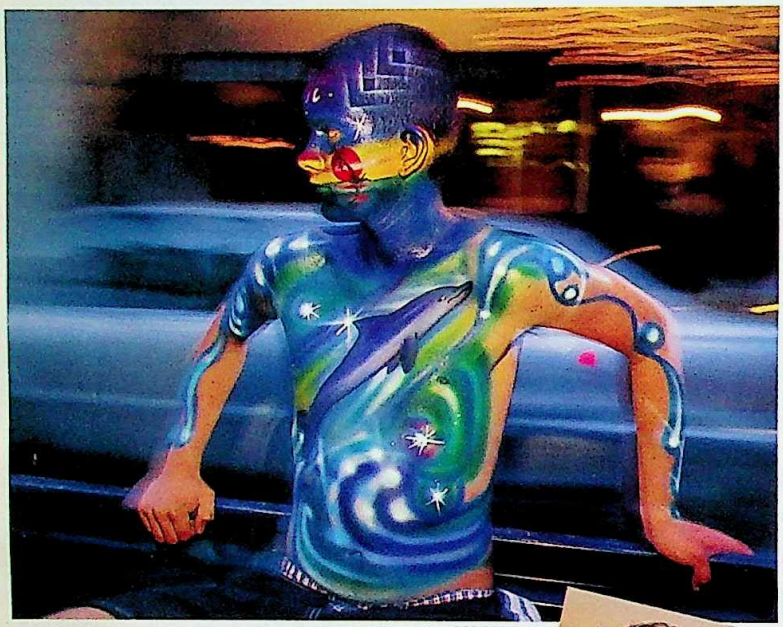
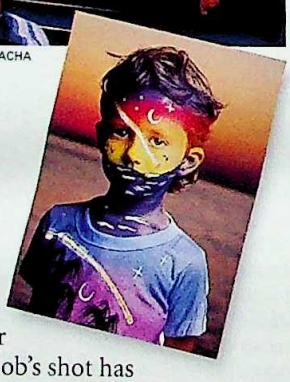
Behind the Scenes



BOB SACHA

A Boy's Airbrush With Fame



Buddy Gregory had a face full of stars (right) when photographer Bob Sacha took his picture for our December 1986 article on Halley's comet. His dad, Key West airbrush artist Tony Gregory, had decorated the five-year-old himself. When Bob returned to the Keys for this issue, he looked up his former subject—and found him all grown up (top). Bob's shot has followed Buddy, now 19, all his life: A poster of it hangs in his father's shop, and he's also seen himself in advertisements. A friend once sent a card of the image to Buddy's family, not realizing who the kid in the picture was. Buddy still gets painted but only for special occasions. "It's not the kind of thing you'd want to do every day," he says.

Cheetah Print

A limited-edition print of Chris Johns's photograph of cheetahs (page 21) is available for $29.95, plus $6.50 for postage and handling ($9.50 for international orders). Please add appropriate sales tax for orders sent to CA, DC, FL, KY, MD, MI, PA, and Canada. We will produce only as many 24-by-36-inch posters as we receive orders for by February 15, 2000. Each print will be hand-numbered and embossed with the Society seal. Shipping is scheduled for April 2000.

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TIPPER GORE

Shooting to Make a Difference

Staff photographer Jodi Cobb joins 12 other artists in "The Way Home: Ending Homelessness in America," a show opening this month at the Corcoran Gallery of Art in Washington, D.C. The project was the idea of Tipper Gore, who hopes the images' emotional impact will make people want to help the homeless. Jodi met Mrs. Gore, an avid photographer, in 1976 after covering Nashville for a GEOGRAPHIC story. When the two traveled to Miami to shoot for the exhibit, Mrs. Gore caught Jodi in action (left) with Connie Seay.

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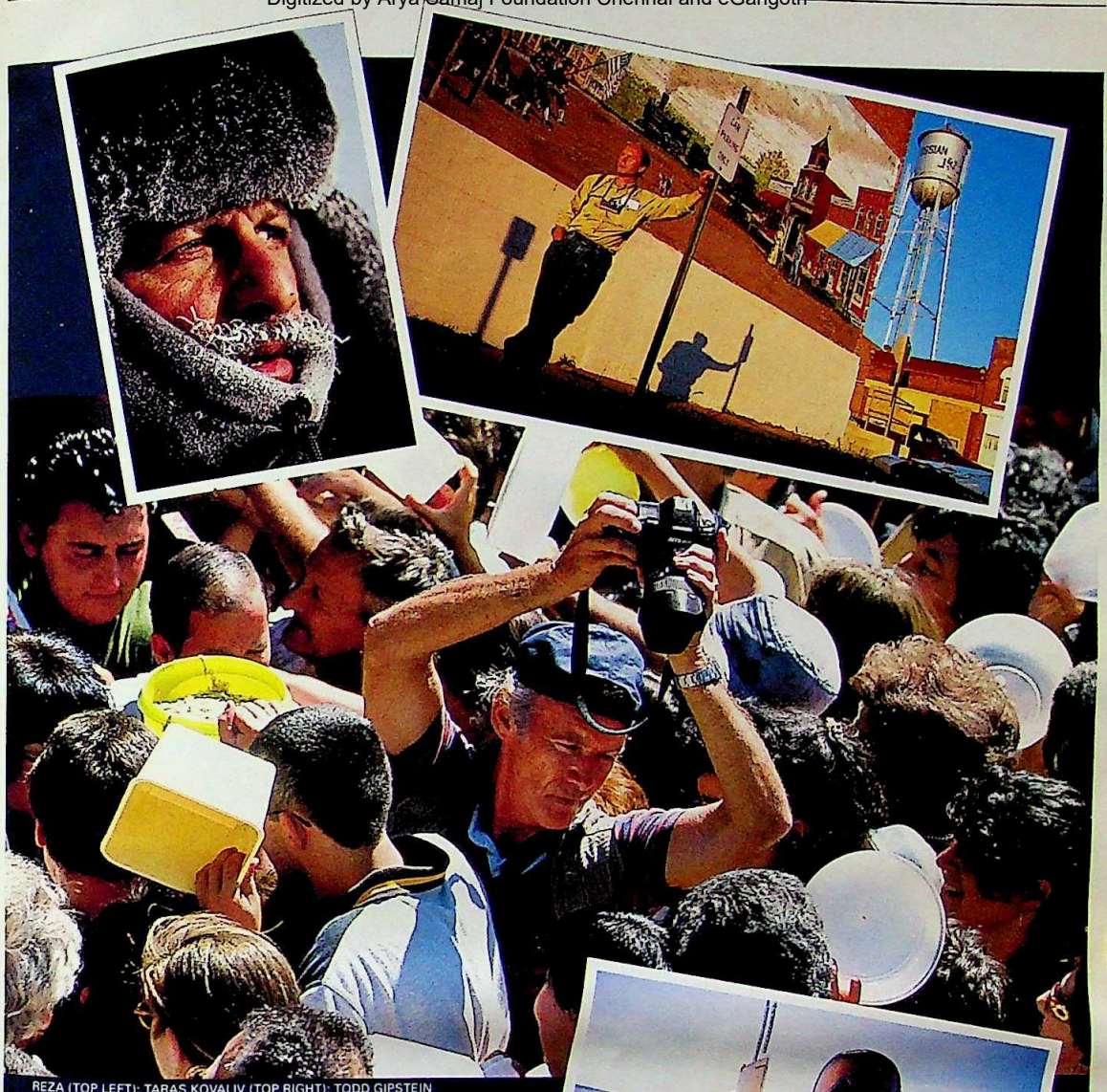

REZA (TOP LEFT); TARAS KOVALIV (TOP RIGHT); TODD GIPSTEIN (CENTER); CAPT. JEFFREY FISCHBECK, USN

Previews for the Year 2000

We've got some good stories in store: Polish photographer Tomasz Tomaszewski got an eyeful of Iowa (top right) when traveling across America to update his outsider's view of the country, published in our January 1988 issue.

For our series on ancient Greece Jim Stanfield (center) waded through a mob at a bull sacrifice—but kept on shooting. Part one debuts this month; parts two and three continue in the new year.

Photographer Reza (top left) survived minus 40° temperatures, though his camera batteries did not, while covering China's Black Dragon River. Jay Dickman (above) was literally on thin ice while waiting to photograph an Arctic submarine. When the surface under his heavy, camera-laden sled gave way, he was dumped into the drink. "I'm six feet tall; that water is 12,000 feet deep," he says. "That's all that kept going through my mind."

TEXT BY MAGGIE ZACKOWITZ

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CartoGraphic

Mapping Ecosystems for Conservation

The rapid pace of global development is forcing conservationists to ask tough questions.

Which pieces of Earth's tattered patchwork of habitats are the most biologically diverse? Which face the greatest threats? Where should the efforts to save endangered ecosystems be concentrated?

Biologists at the World Wildlife Fund (WWF) have undertaken an ambitious effort to provide some answers. They've compiled a digital map of Earth's terrestrial ecoregions, delineating some 900 distinct units, 114 of which are in the United States and Canada (below).

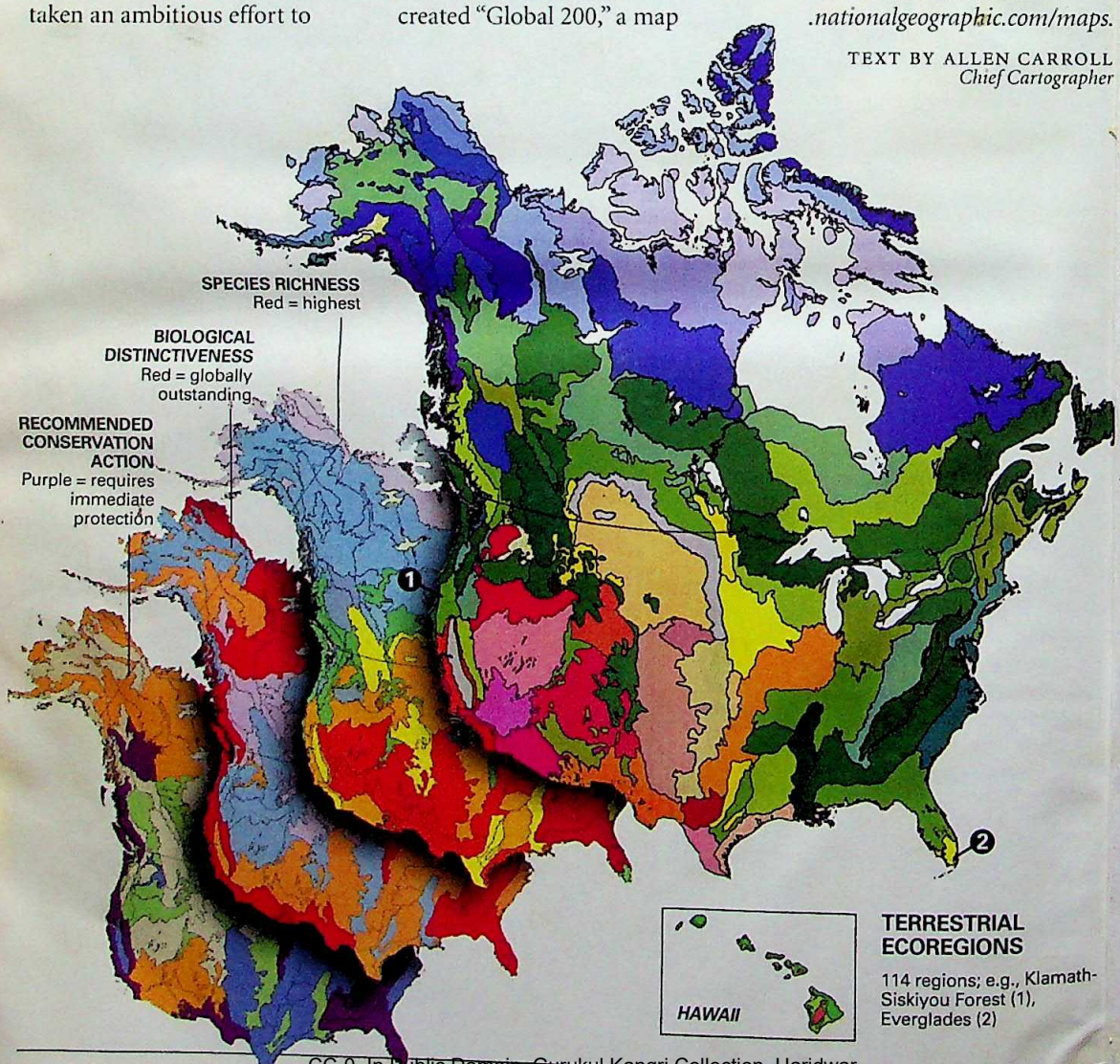
Consulting with dozens of specialists and organizations, WWF is compiling species lists of birds, mammals, reptiles, and amphibians for each ecoregion and noting which species live only in that region.

Analyzing these and other features, the scientists have created "Global 200," a map of the most biologically outstanding regions worldwide.

The next step is determining which ecoregions are in the greatest peril based on habitat loss and risk of extinction for various plant and animal species. This "most endangered" list will aid in rallying politicians, scientists, conservationists, and citizens to come to the rescue of critical ecosystems.

You can tour the "Global 200" map on National Geographic's interactive atlas at *www.nationalgeographic.com/maps.*

TEXT BY ALLEN CARROLL
Chief Cartographer



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